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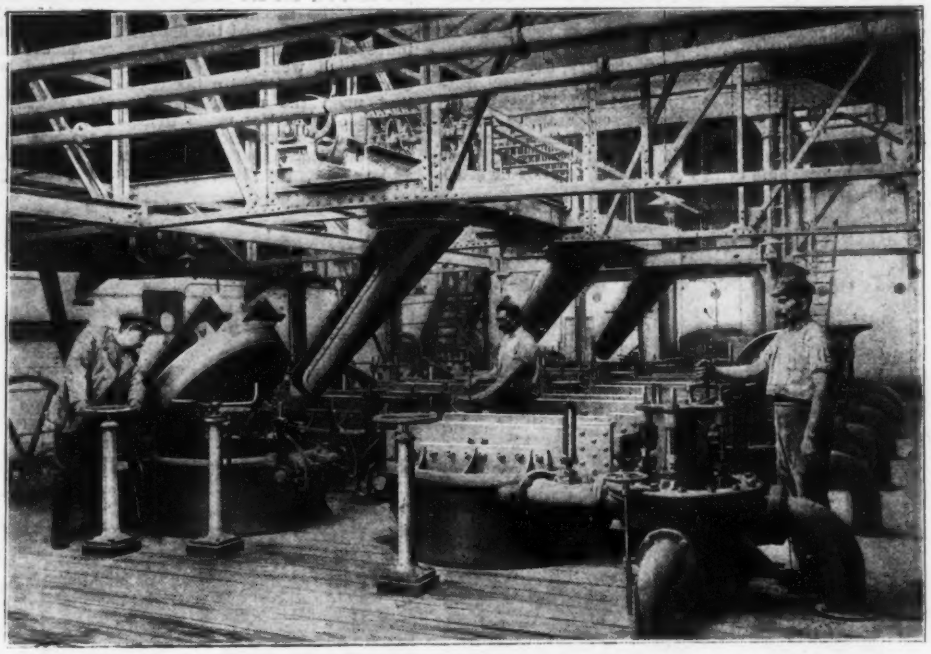
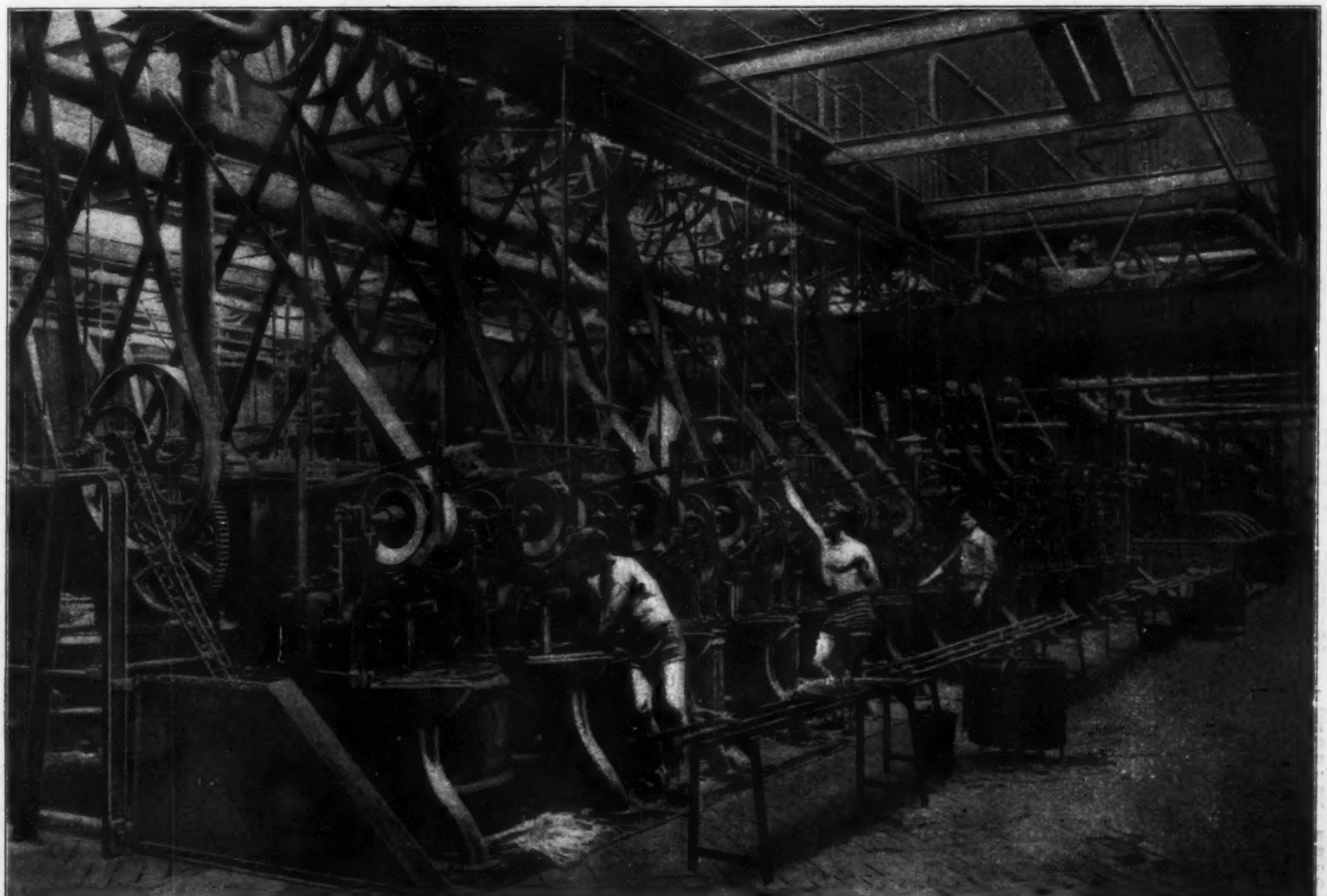
THE BOILING.

The syrup is cooked with steam in a vacuum, thus being transformed into a pasty mass formed of crystals or grains mixed with molasses.



TREATMENT OF THE BEETS BY DIFFUSION.

The beet-roots, cut into thin strips, are placed in the cylinders shown in the engraving, where they are mixed with water under pressure, which absorbs their sugar. From the water, transformed into sweetened syrup, the sugar is extracted, while the remainder of the beet roots is used as fodder for cattle.



VIEW OF THE CENTRIFUGAL SEPARATOR ROOM.

The turbines revolve at 1,500 revolutions per minute and separate the sugar crystals from the molasses. The high temperature (100° F.) obliges the workmen to wear scant clothing.

THE MANUFACTURE OF BEET SUGAR IN FRANCE.

THE FRENCH BEET SUGAR INDUSTRY.

To pay ten cents a pound in France for a food material which is produced by French agriculture and industry, and which it costs but about three cents to manufacture, is strange enough, but the selling of this same material to the English at a figure below the net cost, so that they are able to deliver it to the retail trade at four cents in the London market, is more strange. Such, however, as we shall see, is the result of the fiscal system now applied to French sugar manufacture and traffic.

The cost of a 220-pound bag of crystallized raw sugar, just as it comes from the manufactory, and which is designated as "Confectionery Sugar," is now about five dollars. In order to convert this into loaf-sugar, it is necessary to reckon the expense of refining at $1.20, and this brings the cost to $6.20, say about three cents a pound. But, in order to obtain the right to permit of its home consumption, the manufacturer must first pay a tax of $12.80. This gives a total of $19.00 a bag, say 8 7-11 cents a pound, the average market rate at present of the refined sugar that the grocer retails at 10 cents a pound.

If it is designed for a foreign country, say for England, which takes nearly the whole of French exportation (340,000 out of 430,000 tons in 1901), French sugar not only does not pay the domestic consumption tax of $12.80 mentioned above, but is allowed an export rebate of 80 cents per 220 pound bag on raw and of 90 on refined sugar. This brings the figures to $4.20 or $5.30

CLEANING THE SPECIMENS OF BEET ROOTS IN ORDER TO OBTAIN THE TARE BY DEDUCTING THE WEIGHT WHEN CLEANSED FROM THAT AS ORIGINALLY RECEIVED.

DETERMINING THE SPECIFIC GRAVITY OF THE JUICE.

THE MANUFACTURE OF BEET SUGAR IN FRANCE.

per bag (say 1 9-10 or 2 4-10 cents per pound), and that explains how it is possible for the English to sell sugar at what seems to Frenchmen the fabulously low price of 4 cents a pound!

It will be understood furthermore, that, under such circumstances, the English with French sugar and French fruits, are capable of manufacturing preserves which they subsequently sell in France at prices lower than those at which French manufacturers can sell in the Paris market. It would be for the interest of the French housekeeper, carrying a basket of fruit upon her right arm and a basket of sugar upon her left, to go to England to make her preserves, which would thus cost her less, despite the customs duty of about 3 1-5 cents a pound that she would have to pay on her return home.

France is not alone in manufacturing sugar for the English at a loss. The Germans and Austrians are competing, at figures much more favorable to satisfy England's enormous consumption, which is relatively the greatest in the world—nearly 2,000,000 tons annually, say 100 pounds per inhabitant. The Frenchman consumes but 36.5 pounds and the German 30.5, while the American approaches the Englishman in the consumption of 66.

It is hardly conceivable, and yet it is true, that the English have got tired of a state of things that assures them of sugar at so low a price, and are complaining of the introduction of foreign sugars as proving prejudicial to the development of their colonial production; or, more accurately speaking, it is the colonists themselves that have addressed remonstrances to the metropolis on this subject. It is for this reason that they last year brought about an international conference at Brussels for the reformation of the economic handling of sugars. The resolutions of this conference, which have now been submitted to the consideration of the French parliament, will probably have the effect of revolutionizing the French fiscal system and involving a diminution in the price of sugar in the home market by doing away with some of the anomalies mentioned above.

Up to 1884, the tax on sugar was levied in France upon the manufactured product at the rate of $14 per 220 pounds (about $6.37 per 100). Sugar was then worth $14, and the tax doubled its selling price. At this early day, the output of the French manufacturers was scarcely 7 or 8 per cent of the weight of the beets, not only on account of the paucity of the raw material, but also of the imperfection of the processes of extraction employed. During this time, considerable progress was making in Austria and Germany from an agricultural view point, through improvements in the culture of the beet and the substitution of the "diffusion" process, which permits of the extraction of the sugar with an insignificant loss of ¼ per cent for the old press-process, through which 2 per cent of the saccharine juice was lost. Enlightened minds comprehended the danger that the French sugar industry was exposed to, and suggested the new fiscal law which went into effect in 1884, and which in Germany substituted a tax upon the raw material for that upon the manufactured article. The salutary effects of this law made themselves quickly felt. A variety of the beet rich in sugar was obtained by selection, diffusion apparatus were imported and improved, and the average yield, which twenty years ago was 5 per cent, now reaches 11 and 12. The net cost of production with the Germans, who have continued to advance, is about 50 cents a hundred less than with us, for the reason that they have in addition the advantage of having cheaper labor at their disposal, and that their agriculture is not so heavily burdened.

The law of 1884, which has been modified several times, imposed a tax of $12.80 per 220 pounds (about $5.80 per 100), calculated upon an average production of 7¾ per cent. All additional that the manufacturer obtains up to 10½ per cent pays but half of this tax, and only a quarter of the tax is demanded for anything obtained over and above this figure. This is a rebate to the industry that favors the skillful manufacturer. Under the impetus of the new law, the income from the sugar tax, which was but $28,600,000 in 1883, exceeded $40,000,000 in 1899. But the disadvantage of the system consists in a large overproduction. Thus, from 480,000 tons in 1884, France has at present reached 1,100,000 tons, while through the efforts of German competition prices have dropped from $6.37 to $2 per 100 pounds.

In 1897, the Germans having instituted export rebates (called "war rebates") they were answered by the corresponding French rebates, which we have already mentioned, and which allowed French commerce to keep up the struggle still further.

We now come to the Brussels Conference, which ended its deliberations last March. The international understanding that it established obliges the contracting countries to abolish all direct or indirect rebates, and to establish a uniform customs duty of 50 cents per hundred pounds upon raw and of 55 upon refined sugar. This new state of things involves the reform of French internal legislation. French export trade will greatly suffer from it, and the English will have attained their object, which was to disburden themselves, in part, of foreign sugar. German competition will surely dispute the market with France victoriously. Owing to her net cost of 50 cents per 100 less than France's, she will easily compensate for the 50 and 55 cents imposed by the new customs barriers. France must therefore make special effeorts to increase its home consumption.

The 36.5 pounds per individual, compared with the 100 pounds of the English, sufficiently shows that if no more sugar is consumed in France, it is because it is too dear. It is not a question solely of the domestic consumption of sugar that is put into coffee or into food, but especially of the industrial consumption, which ought to amount to two-thirds of the total figure, if it is possible to profit by the new situation in such a way as to restore to France the manufacture of saccharine food products that has emigrated to foreign lands.

The government has understood this, and the internal fiscal regime project that the Minister of Finances is going to support before the Chambers, as a consequence of the Brussels Convention, reduces the consumption tax from $5.80 to $2.45 per 100 pounds.

The diminution that will result therefrom, taking into account the abolition of manufacturing rebates, will be about $2.75 per hundred. France will then have sugar at 7¼ instead of 10 cents a pound. This will be a great progress that will be capable of rapidly increasing the amount of consumption and give the State the same receipts as with the present system. Any further diminution, such as that of the 2½ cents a pound first proposed, would prove inadequate to increase the consumption, or would simply inure to the benefit of middlemen.

We have said that a great revolution in the processes of manufacture was the consequence of the law of 1884, and apropos of this, it has appeared to us that it would be of interest to our readers if we described a large sugar works provided with every modern improvement.

In France, there are at present 333 sugar manufactories distributed among 23 departments. The most numerous are grouped in what is called the "Sugar district," which comprises Nord (80 factories), Pas-de-Calais (41), Somme (50), Aisne (72), Oise (30), and a portion of the departments of Seine-et-Marne (13), and of Seine-et-Oise (10). The largest, to the number of a dozen, produce, each of them, per year, 100,000 bags (220,000 pounds) of sugar. Four, which are the most extensive sugar works in France, reach or exceed 200,000 bags (484,000 pounds). These are the works of Pont d'Ardres (Pas-de-Calais), of Abbeville, of Escaudœuvres near Cambrai and of Villenoy near Meaux.

All these works, collectively, manufactured during the last "campaign" (1900-1901), 1,100,000 tons of sugar. Such a production necessitated the use of 8,700,000 tons of beets, cultivated upon more than 600,000 acres.

The difficulty of preserving the beet necessitates the reduction of the duration of manufacture or annual "campaign," which opens in October and closes in December, to a period of two months or of two and a half at the most, dating from the gathering of the crop.

Such necessity of working very quickly would, in certain cases, limit the importance of a sugar manufactory to the quantity of beets that it would be possible to supply itself with every day, provided that it

were content with the usual method of transportation by carts, railway, and boats. So, in order largely to increase the power of obtaining supplies, and, consequently, the manufactories' productive capacity, it has become the custom to rasp the beets not only at the works, but also at special rasping mills established upon the fields of culture, whence the saccharine juice is forced by pump to the sugar manufactory through a subterranean pipe-line. The manufactory then takes the name of "central works." There are central works that are supplied in this way by 15 rasping mills situated within a radius of 6, 12, and 18 miles. This curious process, which has been applied by some fifty French works, is both practical and economical. The manufactory that we are going to describe is a large central works which is provided with 15 rasping mills and which daily converts into sugar the juice furnished by 4,484,000 pounds of beets, corresponding to an average manufacture of 2,500 220-pound bags of sugar.

Thirty years ago, sugar was still manufactured by extracting the beet juice by means of a hydraulic press and boiling it in the open air. The product did not exceed from 7 to 8 per cent, and it took 15 days to convert the saccharine matter contained in the cells of the beet into sugar colored more or less yellow by a remnant of molasses. At present, such conversion is effected in 24 hours and the sugar obtained represents 12 per cent of the weight of the beets treated. This sugar is in crystals that are entirely white and almost chemically pure (99.75 per cent). The first stage of the manufacture comprises the treatment of beets in order to extract the juice from them. This is the work of the rasping mills above mentioned. Let us recall the fact that the roots, first cut into strips, are subjected to the action of water under pressure in diffusion apparatus, which extracts from them the whole of the sugar within about ¼ per cent. The saccharine juice, immediately mixed with lime, which purifies it and preserves it from alteration by converting it into sucrate of lime, is sent to the central works through the underground pipe-line of which we have spoken.

The juice coming from the different rasping mills is received at the works in large reservoirs that, in a manner, form the starting point of the manufacture proper. From here it passes into huge coppers in which it is mixed with carbonic acid, which separates the lime from it in a state of carbonate, as well as the other impurities. Then it is filtered through fifty jute cloths in a series of press filters.

The clarified juice is then sent into what is called a "triple-effect" evaporating apparatus, formed of three copper vessels of from 13,200 to 15,840 gallons capacity, heated by steam. Therein, under the action of a methodical evaporation and successive condensations, it undergoes a concentration that converts it into sirup. This latter, after a new filtration, is boiled in a vacuum. In two vessels having the same total capacity as the evaporating apparatus, it is raised to a high temperature, the action of which may be prolonged, owing to the vacuum, without any risk of altering the material. The sirup is soon converted into a pasty mass in which there form grains or crystals of sugar, which gradually increase in size. After the operation is finished, the boiled mass is poured into crystallizers, in which it is agitated and cooled. Under this double action, the crystals of sugar cease increasing in size, and all that remains to be done is to separate them from the sirupy material which envelopes them and which is nothing else than molasses. The separation of the sugar and molasses is effected in centrifugal turbine separators.

The perfectly white sugar extracted from the turbines is raised mechanically to an upper story, where it is thrown into hoppers and screened. The screening permits of dividing the material into first class sugar with regular grains, and second class sugar. Both, weighed and put into 220-pound bags, are placed in storage for delivery to the trade or to be sent to the refinery.

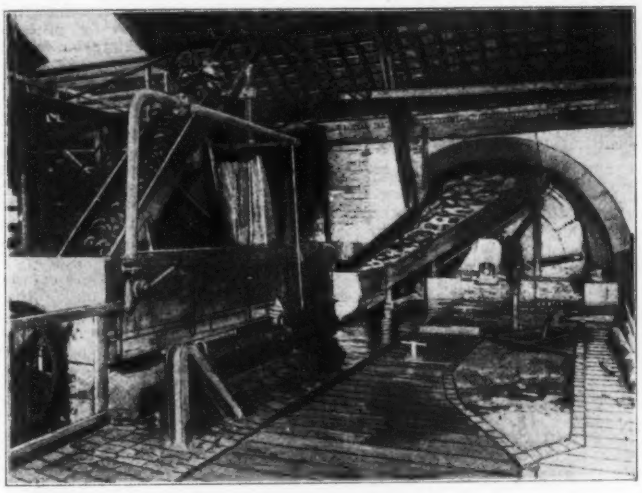
Thus far we have spoken only of the conversion of the beet juice into sugar; but, during the course of the manufacture, residue and by-products are formed that all come into play; for, in the manufacture of sugar, it may be said that nothing goes to waste. In the first place, the strips or narrow slices of beets, exhausted by diffusion, are sold to farmers for cattle food. After the liming and filtering, the scum and solid materials extracted from the apparatus are sold as fertilizers. Finally, the molasses derived from the turbining is submitted to a new operation and the resulting product is shipped to the distilleries.

Accessory manufactures are ingrafted upon that of sugar. The lime for the treatment of the juice is produced at the factory itself in special furnaces in which is, at the same time, collected the carbonic acid necessary for separating the lime and other impurities from the juice. The heating of the evaporating, boiling and other apparatus absorbs an enormous amount of steam, which, added to that required by the motors, explains the exceptional importance of the battery of coppers of a sugar manufactory. Finally, electricity plays its part in lighting and the transmission of power.

A word as to the refinery. The sugar, of which we have just described the method of manufacture, presents itself in the form of white crystals that are as pure as possible. It might be directly consumed in this form, but the use of it, in France at least, has not become general. It is employed in this state mostly for sugaring sweetmeats, and in the confectionery, chocolate, and wine industries.

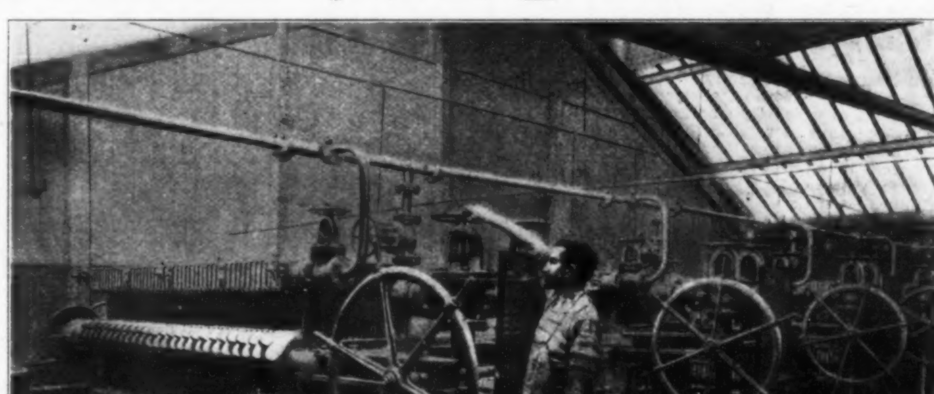
The refinery undertakes to give it a commercial form, in the shape of loaves, cubes and mechanically crushed lumps. It also, at the same time, treats low grade products, second class sugar of a more or less brown color, and partially manufactured sugar from beet-sugar factories. All such products are converted into compact sugar of which the form, consistence and color vary according to each nation. The French prefer a white sugar, in loaves or broken mechanically, with a fine crystalline texture. The English have a predilection for sugar in cubes, with large facets, which seems like a conglomerate of crystallized white sugar. Finally, while the French insist that sugar shall be perfectly white the Russians require that it shall be of a yellow, green, or even of a violet tint. These various desiderata are satisfied by one and the same process. In order to have a very white sugar, the refiner adds to it a very small proportion of ultra-marine blue. The Russians increase the proportion of the coloring material, which, mixed with sugar that has been rendered more or less yellow, by a remnant of molasses, gives the desired tint.

Such, in its broad lines, is the sugar industry that occupies so prominent a place in France, and the prosperity of which is intimately connected with that of its agriculture. It is to be hoped that the new transformations that it is to undergo will have the effect of strengthening such prosperity and of increasing the consumption of a food product of the first rank, which has the rare privilege of being manufactured honestly and free from any adulteration.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the French of G. Cerbelaud, in L'Illustration.



WASHING THE BEETS.

The beets, carried along by a current of water in a chute, are picked up by a wheel which transfers them into rinsing baths, from which they are lifted by an endless screw to a cutter on the floor above.



THE FILTER PRESSES.

The juices and sirups pass through the filters, where they are forced through fifty jute screens that retain all deposits and impurities.

THE MANUFACTURE OF BEET SUGAR IN FRANCE.

CRUSHED STEEL AND STEEL EMERY.*

AN ARTIFICIAL ABRASIVE PRODUCED FROM STEEL.

By M. M. KANN.

THIS at present well-known artificial abrasive dates back its origin in a primitive way a good many years. Our first knowledge goes back perhaps fifty-odd years, where in extreme cases in the German industries they required a cutting material which was harder than the known abrasives, such as emery and corundum, and which was within the reach of commercial necessity. They resorted to breaking up old files; but of course this was done in a primitive and uncertain way, and on a small scale and in laboratory experiments.

The writer's attention was first called to the article by the patentee, C. M. Lindsey, who being in the marble and stone cutting business conceived the idea of breaking up hard files as a medium for cutting. His efforts in a commercial way were unsuccessful, from the fact that there was no known means of making a uniform product, and the difficulty of breaking the files made it impossible to obtain any satisfactory results.

The writer became interested, and concluded that if methods could be found by which a uniform granular structure could be produced it must prove effective. This investigation resulted in the formation of the Pittsburg Crushed Steel Company, Limited, of Pittsburg, Pa., in the year 1889. After a vast amount of experimental work and a great many unsuccessful results, the proper methods were found to produce the article in uniform grains, structure and sizes of the requisite hardness or toughness, and at a cost of production where it could be put in successful competition with natural and other artificial abrasives. These products are used to-day quite extensively in all the known arts and industries in this and in foreign countries.

This abrasive is manufactured preferably from pieces of high grade crucible steel, heated to a temperature of about 2,500 deg. F. (almost a white heat), and then quenched in a bath of cold water, or other suitable hardening solution, which gives the steel a granular structure. The pieces are placed under powerful hammers or crushing machines and are reduced to small particles, varying from fine powder to grains of many different sizes. The steel particles are then tempered, preferably in the following way: They are placed in a cylinder or pan and heated to a temperature of about 450 deg. F. until the particles change ther appearance to a straw color; they are then cooled by being subjected to cold air in various ways. The material at this stage, or before the tempering process, is graded into many sizes, according to the number of mesh openings of the sizing screen per square inch. The sizes of diamond "crushed steel" run in numbers from No. 5 to No. 60 inclusive. Diamond "steel emery" is similar to crushed steel, but it is given an intensely hard temper, and its numbers range from No. 60 to No. 200 and above.

These two abrasives, so closely related to each other, are used for entirely different purposes in the various trades. Crushed steel and steel emery rank

* Read before the meeting of the American Association for the Advancement of Science, at Pittsburg, Pa.

very close to the diamond in hardness, being 9.27 if the diamond is taken at 10.

Crushed steel is tempered mostly to a tough hardness, while steel emery, having different work to perform, is made intensely hard. A grain of crushed steel, examined under a magnifying glass, exhibits a series of sharp points and cutting angles. In work, as fast as the point is worn down another is presented, while should a grain break it presents on the fractured face a multitude of new cutting points.

Crushed steel and steel emery are now used in the sawing, rubbing and polishing of stone, marble, granite, onyx, etc., in lens grinding, glass beveling, brick grinding, and by lithographers, engineers, and plate glass manufacturers. If a bond could be found, so that these steel abrasives could be placed on the market in the form of a wheel or brick, the length of the above list would be much extended. The stone trade consumes an important amount of crushed steel. The natural abrasive used in the sawing and rubbing of stone for all time was sand, but sand in its use under the pressure and impact of the saw blades or wheels breaks down and dissolves into a slush and loses its cutting properties.

As the necessity for the reduction in cost and increased output arose in the production of stone, granite, marble, etc., chilled iron globules, better known in the commercial world as "chilled shot," took the place largely of sand in the stone trades, and was the only artificial abrasive known. But with the advent of crushed steel and steel emery it had to give way, and while chilled shot is considerably more expensive at first cost than sand, and again crushed steel more expensive than chilled shot, it resolves itself into the question of increased production, and has proven in all cases that crushed steel by its largely increased output has much reduced the cost of sawing and rubbing stone of all kinds. Sand cuts sharply for a little while, but pulverizes, and therefore cuts slow, and must be constantly renewed in large quantities. Chilled shot, of course, being harder, is more effective, but from the nature of its structure rolls under the saw blades or rubber, and thereby crushes the grains of stone; while crushed steel, with its sharp and angular edges, becomes imbedded in the saw blade or rubber and acts as a tooth, and therefore cuts its way into the stone. Being very much harder and tougher than the natural sand, or, in turn, harder and tougher than chilled shot, its lasting qualities are much greater.

The various sizes of crushed steel are used on different kinds of stone. The largest sizes, Nos. 10, 12, 14, and 16, are employed to saw stone of a coarse texture, such as the well-known Connecticut brownstone. The Indiana oölitic limestone is best cut with No. 30 or No. 36, while the finer textured stones, such as onyx and marble, require such sizes as No. 46 or No. 50.

A small quantity of quicklime added to the crushed steel will prevent the oxidation of the steel particles, and has been used to advantage in some of the large marble cutting establishments in the United States.

In rubbing down granite to a surface fit for receiving a polish considerable care must be exercised in selecting the proper size. This is governed largely by the surface left by the stone cutter. Some polishers take the stone to a machine direct from the pointing tool, others from the ax, and others from the four, six or eight cut hammer. The finer the cut from the workman the smaller sized steel is required. A serious mistake, however, is too often made by granite polishers. It has been the custom, from necessity, to bring a very heavy pressure to bear on the rubbing wheel; the formation of the grains of steel renders this great pressure unnecessary; in fact it is prejudicial, because it prevents rapid work.

Grain emery was formerly very largely used by granite polishers. Now steel emery is chiefly employed, and a surprisingly small quantity will smooth down a stone, thus increasing the speed of production.

In stone rubbing, glass beveling and brick grinding iron wheels revolved by power are used. For rubbing stone a plate of 12 to 13 feet diameter is used. In grinding brick this size is reduced one-half, and in glass beveling the ordinary size is 30 inches. But the process is the same in all cases.

The steel is continually kept on the move. From the revolving bed or wheel the grains of steel drop into a circular trough and are scraped out of this trough into a feed box, from whence they are automatically fed to the center of the bed. By means of this device a small quantity of the abrasive is in use.

The Pittsburg Crushed Steel Company have also devised and have in use a number of attachments for the rapid and economical sawing, rubbing, grinding and polishing of stone of all characters, granite, marble, glass, brick, metal, etc.

Crushed steel has taken the place of the diamond in core drilling in many instances, and may eventually supplant it altogether for this particular use. Sixty-five feet of a $1\frac{1}{2}$-inch core of Lake Superior sandstone has been taken out in ten hours with the use of No. 14 crushed steel, and one of the largest cores obtained was taken out with crushed steel from the Cleveland sandstone district, being 130 feet in length and 6 inches in diameter. In practice the steel is fed alongside of a wrought iron pipe, and by the use of water is brought under the revolving pipe, which acts as a bit, the steel taking the place of the diamond under the bit.

Lens grinders are finding out the advantage of using diamond crushed steel and steel emery, both in speed and in cost. The abrasive is used over and over again so many times and cuts so rapidly that were it many times the price of emery it would still prove more economical. The cut always being uniform, the grinder knows just what surface each number will produce. For roughing in No. 70 or No. 90 is used, followed with No. 170 for fining down. Washed flour emery has hitherto been the smoothing medium, but the finest size of steel emery may advantageously be employed for this work, and this material has been employed by some of the most extensive lens grinders in the United States. The Rev. John Peate, of Greenville, Pa., who manufactured the mammoth lens for the American University of Washington, D. C., was very much assisted in his undertaking by the use of steel emery in the operation of grinding what was at that time the largest reflecting glass made in the world. Its application in the microscope and photographic lens grinding has been the means of cheapening the manufacture of this class of lenses.

Steel emery Nos. 150, 160, and 170 has taken the place of French sand in the lithographic trade in preparing the stone and for graining has no equal. Engineers are also finding out the value of this abrasive, which "cuts but never breaks." In grinding metal the work which steel emery will do is considerable, and now all important railroads in the United States and Canada consider it an indispensable material in their shops. Hardened tool steel, against which emery instantly pulverizes and which will resist the bite of a file, yields to the cutting power of these minute grains.

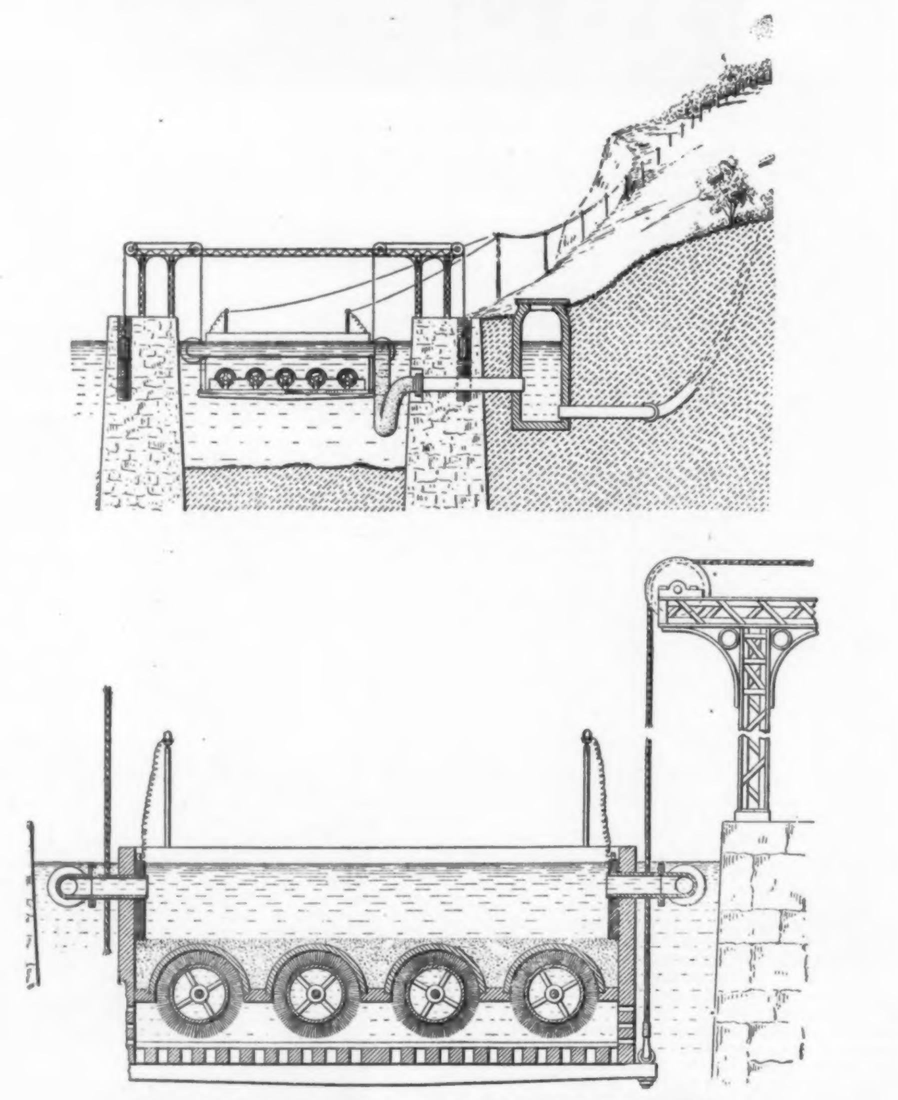
Lack of acquaintance with steel emery may lead the workman to believe that it has ceased to cut long before its power is exhausted. This is due to the absence of the peculiar grating sound produced in its operation, now deadened by the minute particles of abraded metal, which thicken the oil and so prevent the steel emery from doing its work properly. The addition of a little oil permits the grains of steel to move freely and new life is given to it. In ordinary grinding and on flat surfaces steel emery is used in precisely the same manner as ordinary emery, but special care must be exercised in its use because the grains of steel emery are so much smaller than the abrasive heretofore used for the same purpose. Oil must be applied sparingly to prevent the steel emery being drowned or floated away. On curved surfaces, or where there is a double seat, one above the other, it frequently happens that a lateral "dishing" or swinging movement cannot be given. Where such surfaces are to be ground the work should be frequently lifted, so as to prevent grooving.

Some years ago the Pittsburg Crushed Steel Company, Limited, demonstrated the efficiency of crushed steel and steel emery by cutting two large meteorites, furnished by Prof. Henry A. Ward, of Rochester, N. Y. One of them weighed 320 pounds and was sawed in a horizontal saw frame, using eight wrought iron blades, 4 inches wide by 3-16 inch thick and 8 feet long, and set about 2 inches apart. The second was cut with 12 blades under the same conditions and method, but was considerably larger and weighed about 550 pounds.

Cast iron has been employed in various ways by running the molten metal into water, so as to make it intensely hard, but the structure of cast iron does not permit it to withstand the hard use and abuse that is given to the crushed steel in the various fields of its usefulness, so that the cast iron product lacks the toughness, the wearing qualities and the granular structure of crushed steel.

IMPROVED FILTERING AND STERILIZING SYSTEM.*

We show in the accompanying illustrations an improved apparatus adapted to filter and sterilize river water for city use. It is the invention of Dr. Charles V. F. Ludwig, of St. Louis, Mo. Certain novel features are embodied in this system which are employed to an excellent advantage. The filter is immersed in the river or in a flume or channel connected with the river where necessary for protection from ice gorges. Two methods are employed for immersing the filters, one of which consists in floating them in large floats similar to dry docks anchored in the river, and the other in suspending them from a stationary framework. In the latter case a pair of abutments are built in the river parallel to the direction of its current. These form a foundation for the supporting framework, serve to direct the water to the filters hung between them, and afford a protection against floods. The filters by this method can be raised or lowered according to the height of the water, for it is necessary that they be immersed to a certain medium depth in order to avoid the lighter particles which float on or near the surface and the heavier substances which sink to the bottom of the river. To this end the apparatus is suspended on cables or chains passing over pulleys on the framework and counterweighted so as to facilitate raising or lowering of the filters when necessary. The filtering apparatus is built in sections or cells in which one or more may be combined according to the needs of the city. The cells are independently suspended and may be individually raised for repairs when necessary. The upstream end of the series of cells is provided with a triangular projecting part adapted to deflect all refuse or floating matter from the filters. The filters consist of tanks whose sides and ends are impervious to the water of the river. The bottoms or floors of these tanks are constructed of porous plates through which the river water filters in. The porous plates are semicylindrical in shape, with their concaved surfaces facing the bottom of the river, and are securely held in a frame or grid. A layer of sand covers the upper surfaces of these plates and this can be readily renewed whenever desired without incurring much expense. In order to keep the filter plates as clean as possible, spiral brushes are mounted to rotate within each arched plate. These brushes are rotated by the current of the river acting on screw propellers mounted on the brush shafts at each end. A slow rotary motion of the brushes is thus constantly maintained which serves to scrape off the impurities collecting on the filter plates and to permit the particles to float off with the current. The importance of this arrangement is apparent to all and forms the principle claim to novelty of Dr. Ludwig's system. Since the



THE LUDWIG FILTERING AND STERILIZING SYSTEM.

* Specially prepared for the Scientific American Supplement.

apparatus is self-cleaning, it not only saves great expenses to the city water department, but also prevents the water from becoming impure by reason of accumulated sediment propagating all manner of disease germs. As a protection for the filter plates and brushes, each filter tank is provided with a second bottom whose perforated walls serve as gratings or screens to exclude the large floating objects. In order to further purify the filtered water in the tanks Dr. Ludwig provides the opposite sides of each cell with carbon plates which are electrically-connected with a dynamo at a suitable distant station. The current of electricity is thus passed through the water in the reservoir, serving to sterilize and purify the same. The purified water flows from the upper portion of the filter tank into a flexible pipe and discharges in a cistern or other water-collecting vessel arranged on the shore. The cistern is located sufficiently low in the ground for the water to flow into it by its own gravity from the filter tank. A pipe connects the bottom of the cistern with the pumping station whence the water is pumped to a reservoir or directly to the city mains for distribution. When it is deemed necessary to clean the filter it may be easily hoisted out of the water by increasing the counterweights, or by pulling on the supporting cable. In the event of the water not having force of current sufficient to rotate the propeller wheels other mechanical motive power can, of course, be applied for the purpose.

THE LANGLEY AERODROME.

To the Editor of the SCIENTIFIC AMERICAN:

I appeal to your sense of justice, impartiality, and truth to give prominence to this correction of a statement in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 1404, November 29, 1902. The means of verification are in the Smithsonian Institution, and I inclose copies for your inspection.

In the article on "The Langley Aerodrome," dated April 12, 1901, there is this paragraph:

"The great difficulty of the task of creating a flying machine may be partly understood when it is stated that no machine in the whole history of invention, unless it were this toy of Penaud's, had ever, so far as I can learn, flown for even ten seconds; but something that will actually fly must be had to teach the art of balancing."

Now I assert that from the undeniable proof offered by the letters inclosed Mr. S. P. Langley and Mr. G. E. Curtis on February 11, 1891, knew all about the existence of my flying machines.

Secondly. Had critically examined and pointed out errors in my figures about my compressed-air flying machine.

Thirdly. Had desired to buy one or two of my machines for £4 or £5 each.

Your published statement makes my successful flying machines prior to the date of the first flight of the Langley aerodrome (May 6, 1896), appear to be unknown, unpublished, and worthless links in the chain of evolution of the coming practicable atmospheric means of transport.

I await your verdict on this matter.

LAW. HARGRAVE.

Woollahra Point, Sydney, N. S. Wales, January 7, 1903.

P. S.—There is a well-known law among investigators of nature that the honor of discovery goes with priority of publication; and that this honor is something to be desired is obvious from the stereotyped phrase announcing the extended interval of time over which a man has worked on his particular job, the results of which he is now willing to publish for the benefit of mankind.—LAW. HARGRAVE.

[We have read the letters above referred to, and from them it would seem that Mr. Hargrave is justified in taking exception to any broad statement that Prof. Langley knew nothing of his machine prior to the successful trial of the Langley aerodrome on May 6, 1896; for at first reading of the paragraph quoted above, it would seem to imply this lack of knowledge. The paragraph is rather abruptly introduced into the article, and follows a description of Prof. Langley's first experiments in Allegheny, Pa., and a statement of the lessons learned therefrom. Possibly the paragraph may be capable of a broader interpretation than that given it by Mr. Hargrave, and we deem it a fair supposition that Prof. Langley referred to the date of these early experiments as the date prior to which he knew of no successful flying machine.—ED.]

TRYING TO STOP THE WORK OF THE TEREDO.

AT the monthly meeting of the Pacific Northwest Society of Engineers, held in Seattle, Wash., on October 6, there was discussed in detail the interesting topic of the teredo.

F. W. D. Holbrook, civil engineer of the Puget Sound navy yard, who read the principal paper on the subject, says that the impression of the teredo is that he is a small animal, and that he makes up for his lack of size by his industry. Mr. Holbrook exhibited a couple of specimens in bottles that measured fifteen inches in length. He made the astounding statement that teredos had been found at Port Blakely that measured eight feet in length, so from a troublesome little worm the teredo leaped with one bound to the dignity of a sea monster.

James E. Blackwell, second vice-president of the society, who presided at the meeting, called attention to a new terror that has lately invaded the Pacific waters. The name of the new wharf destroyer is the limnoriæ, and he operates in bunches. So numerous is he that the plural is always used in speaking of his kind. The limnoriæ is a sort of scavenger, and he has a feast off that part of the pile not devoured by the teredo. The limnoriæ is about the size of a pinhead, and he is a very busy animal. They have been known to trim the end of a pile down like the sharp end of a pencil, and Mr. Blackwell said they are becoming so common in the Pacific waters that measures will have to be devised to protect the piling against them.

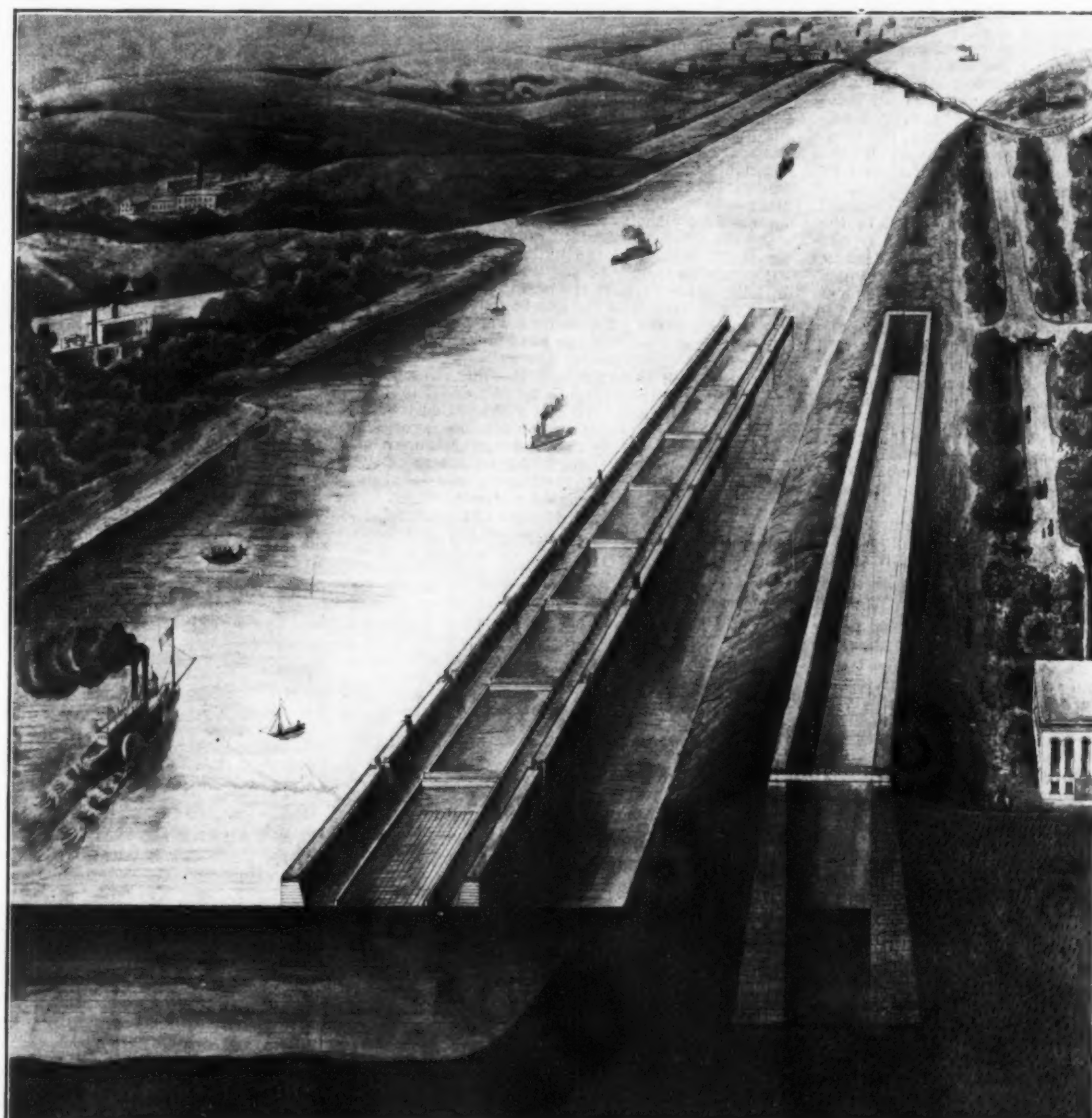
The meeting was very largely attended, and with a subject so interesting the discussion was quite general. The debatable point was the merits of treating the piling to prevent the ravages of the teredo, and the advocates of creosoting and wrapping by burlap were about equally divided. Casing the piling with copper was admitted to be the best plan, but the expense is too great. Studding the face of the pile with broad-headed nails, and covering the surface with cement, were admitted to be good, but again the expense is too great to bring it into practical use.

An instance was cited of a pipe line built of piling near one of the mills near the city. The teredos had a banquet, and after three months of gorging of the dainty fiber the pipe line broke down. The life of the pile in the northwestern waters, treated with creosote or burlap, varies from ten years to an indefinite period, and in the opinion of the engineers these two methods are the best known so far. A gentleman was present who is working on a chemical process to preserve piling, and he was invited to talk. He said he was still working on the matter, and was not ready to make it public.

The paper read by F. W. D. Holbrook, on "Some Remarks on the Teredo and the Limits of its Action," was the event of the evening, and a vote of thanks was tendered him for it. Mr. Holbrook spoke in part as follows:

"There are several species of teredo in the United States, but the one to which my remarks are here confined as of particular interest is generally known as the *teredo navalis*, a marine wood borer which is and has been for years ravaging timber structures exposed to salt water action in this immediate vicinity.

"The teredo, then, as here generally found, is one of a diameter of from one-quarter to one-half inch, of a length of from ten to eighteen inches, and has a smooth, translucent body of a substance similar to that of a clam or oyster. At one end it is equipped with a boring shell, and at the other end are the separate extremities of two tubes which are continued through the body, one serving to take in, from the outside air, water and food for the support of the animal, and the other to carry out the refuse, due both to the boring and the physical processes which sustain its life. These tube terminals are kept at the exterior of the timber, where the teredo first enters, and keep



METHOD OF IMMERSION BY FLOATING DRY DOCKS.

up communication with the outer water. The teredo when it settles on a pile is very small, and begins by entering with a perforation about the size of a small pinhead, but it shortly enlarges after entry and develops rapidly.

"Among the noticeable points of the animal are these: It must always command the opening to the water, and it objects to crossing a crack; on this latter account it does not attack readily piles on which the bark has been retained, avoiding the junction between the bark and the wood.

"The life of ordinary piling unprotected against the teredo in these waters varies, so far as my experience goes, from six months to two years, depending on location and surrounding conditions. Piles in the Seattle water front have been known to be entirely destroyed in six months, while at other points near they are often safe for two years.

"In order to effectually limit the destructive action of this animal, various protective devices have been tried, but in this locality only two are in present use, and it has not as yet been definitely decided which should have the preference.

"One consists in virtually providing for the pile an artificial bark consisting of a strip of burlap 12 inches wide, saturated with a chemical mixture, poisonous to the teredo, and, by the aid of a machine, wound spirally about the pile, lapping so as to give a double thickness of about three-eighths of an inch, with broken joints, and this again confined by a galvanized wire spirally wound and securely fastened.

"The second method of pile protection in use on the Pacific coast consists in treating the pile or timber by the so-called 'creosoting' process.

"The method of gaging the results to be obtained by the number of pounds of creosote injected to the foot of timber treated, while probably sufficiently correct to be depended upon in woods of uniform density, does not appear to be reliable in the case of Puget Sound fir timber, and in particular of piling, which is lacking in such uniformity. The butt of a pile here is usually very dense and pitchy, and compared with the top of the pile, which is softer and less dense, will take up much less creosote. It is also noticeable that in the same section of a fir pile after treatment the penetration of the creosote varies considerably in depth at different points of the section.

"What apparently should be secured is a certain minimum depth of penetration of the creosoting fluid as indicated by the dark band of injection, next to the exterior of the pile; and the depth should be sufficient for the purpose required, as no excessive depth of injection at one portion of the pile is of much value if accompanied with too small a depth at any other portion. In my opinion this minimum depth should not be less than five-eighths of an inch.

"A tried method consists of taking the piles after they have been treated by the first method, that is, wound with chemically-treated burlap, and jacketing them with strips of creosoted fir timber one inch thick by two wide, placed at small distances apart and fastened to the pile outside the burlap with copper nails. This, if properly done, would seem to be effective; and if it is sufficiently cheap in first cost, merits attention.

"There is very little, if any, question that the creosoting process if properly done is perfectly effective, but it is costly, as the whole has to be treated; it is said to weaken the pile and make it brashy, and when exposed to abrasion, as in fender piles for instance, it requires to be protected by outside strips.

"The piles treated by the burlap process need only to be protected where exposed, and the pile timber preserves its full strength. A creosoted pile, however, admits of a closer inspection after treatment than one wound with burlap, which is concealed by its wrapping."

THE APPARENT CHANGE OF POSITION OF THE BULL'S EYE ON A TARGET DURING THE DAY.*

By DR. FRIEDRICH W. F. RIEHL.

HAVING acquired considerable experience in target practice, I believe I have discovered what appears to be a very remarkable and important law in regard to the apparent change of position of an object aimed at during the day.

I found a long time ago, on several shooting ranges, that the bull's eye, a 12-inch black disk on a 4-foot white target, apparently changes its position during the day. This can be observed most accurately if the shooting range extends from south to north, with the target on the north end, if the sky remains entirely clear, and no wind interferes with the course of the bullet. For instance, if the marksman has set the front and peep-sight of his rifle, at 12 o'clock noon, so carefully that he will hit at this time, with proper aiming, exactly the center spot of the bull's eye, viz., twenty-five rings on a twenty-five-ring target, if he tries the next morning at about 8 o'clock with the same position of the gun, with the same setting of the sights, and all other conditions, including cartridges, unchanged, to hit the center spot again, he will, as good a marksman as he may be, certainly make a failure of it. His shot will be marked high left! With progressing daylight, if the marksman continues to shoot at the same spot at regular intervals, and all the conditions named remain unchanged, the hitting marks on the target will present a distinctly semicircular line, *A*, which gradually descending, will traverse at 12 o'clock exactly the center of the bull's eye, then, ascending again, will end at about 4 o'clock high right on the target, opposite the initial hitting mark of the morning. Therefore, if the marksman intends to hit the center in the morning, he would have to aim and to fire his gun as if the bull's eye was not situated in the middle of the target, but near the right low corner of it. To have the same favorable result during the rest of the day, he would have to follow the apparent course of the bull's eye, as if it was moving from low right high up to the middle of the target and then down again to the left and low corner, imitating, as it were, the course of the sun on the target, *B*. The position of the gun has to be changed each time by the marksman sufficiently to follow this apparent curve of the bull's eye, if the marksman wishes continually to hit the center. It must be kept in mind, that a fine target rifle has two movable sights, one front-sight, near the muzzle, to determine the side deviations of the barrel, and one back-sight (called the peep-sight) near the lock of the gun, to determine its elevation. I found, and every good marksman of my acquaintance found so too, that in the morning, when the sun was near the horizon, I had to aim at the bull's eye, as if it was situated a little to the low and right; that means I had to screw my front-sight to the left, and the back-sight low down, *C*. As the sun was ascending and wending its way to the left, the front-sight had to be moved to the right, and the back-sight upward. At noon, when the sun was crossing the meridian, the pin-head of the front-sight was right over the middle of the barrel and the upward movement of the back-sight; that means the elevation of the barrel had reached its maximum, *D*. With the setting of the sun, the downward movement of the back-sight had reached its lowest point and the front-sight occupied a place farthest to the right, *E*. After the laws of abscisses and co-ordinates, a point that is subjected to two regular movements, first upward and to the side, then downward again, will assume a circular or elliptical movement; the image of the bull's eye will do the same under those conditions. It is self-understood that the screwing and changing of the sights by an expert marksman is never done after bad shots, but only when he has aimed well, has kept his gun steady, has come off well, and yet has missed his mark. Then, when all other conditions are right, when his barrel is clean, his ammunition in order, he knows that something must be the matter with the light—that means the bull's eye has seemingly changed its place!

I have tried to calculate roughly the amount of this apparent change of the bull's eye. Having arranged all points as simply as possible, I assume extreme conditions, either early in the morning, or late in the afternoon. The length of the gun-barrel may be 1 meter, of the shooting-range 200 meters, *F*. Then the course of the bullet at 8 o'clock the next morning will form the hypotenuse, the course of the bullet at 12 o'clock noon will form one cathetus, and the line, which joins the two hitting marks formed by the end-points of those lines on the target, will, in a right-angled triangle, present the other cathetus, or the possible error, *X*, which will be made even by the best marksman, if he disregards this apparent change of the position of the bull's eye. Near the apex of this right-angled triangle we have another smaller right-angled triangle, whose one cathetus is represented by the length of the barrel, 1 meter, and the other by the distance to which it is necessary to change the position of the front-sight, so that the error in shooting may be corrected and the bullet may hit the center.

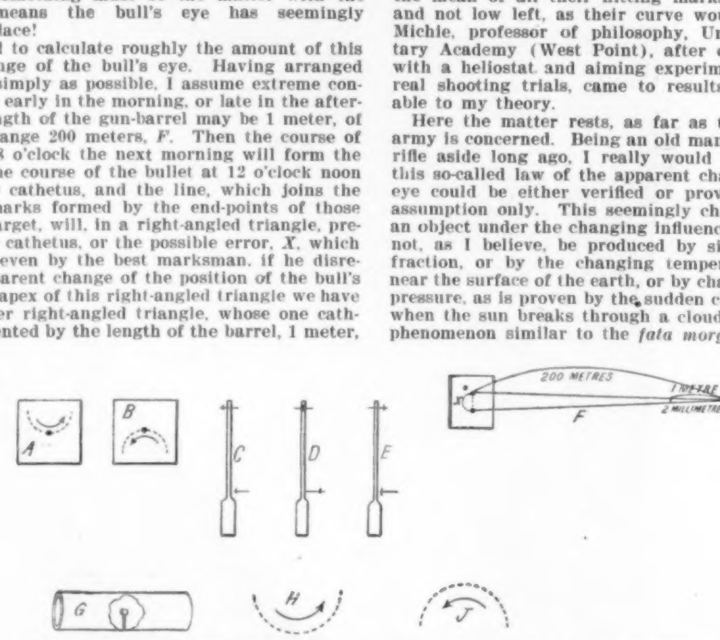


DIAGRAM ILLUSTRATING THE APPARENT CHANGE OF POSITION OF THE BULL'S EYE IN TARGET SHOOTING.

I have always found that this correction, either in the morning or late in the afternoon, required a screwing of the front-sight from left to right, or *vice versa*, at least for about 2 millimeters from the noon-time setting of the sights. Therefore we have the simple proportion $1 : 200 = 0.002 : x$; $x = \frac{200 \times 0.002}{1} = 0.40$ meter = 16 inches (about). That means the marksman would have hit the target 16 inches distant from the center—instead of twenty-five rings he would have made not more than ten rings, which corresponds very well with practical results.

This phenomenon presents itself so clear and invariable, that I have found it necessary to screw the peep-sight several millimeters higher at noon-time in summer than in winter, according to the higher stand of the sun, as I think.

This apparent change of the position of the bull's eye may be observed even when the sky is clouded, independently from the stand of the sun. If all at once the sun should break through anywhere, and a cloud should happen to be ornamented with a silver lining, the bull's eye is sure to change its position in the direction of this illuminated spot, and a hasty readjustment of sights will be found necessary.

Therefore I have formulated this law (as it appears to me) of the changeability of the position of the bull's eye in the following manner: "The bull's eye is apparently attracted by the position of the sun or of any other luminous point, and apparently during the day follows the course of the sun in a semicircular line on the target." The practical deduction of this law, therefore, is: "To aim at a lighted object, as if this object was drawn a little to the position of the light."

I do not know whether this phenomenon has been observed before by any one else. It certainly is now recognized as correct by the best marksmen of our California shooting clubs, especially by Mr. A. Strecker, the champion target-shot of the United States.

These facts, as I have expressed them in said law, seem to me of immense importance for every one who wishes to become a good shot. With the enormously increased range of the modern rifle, the error caused by the change of light must be increased too according to the distance traversed by the shot. If this law should be found to hold good for guns of small caliber, it certainly will hold good too for guns and cannons of the largest caliber.

The headquarters of the United States Army were apprised by me of these observations as early as 18[illegible]. A commission of officers, some of the best shots of the army, were appointed to investigate this phenomenon at Fort Leavenworth, Kansas. On account of a somewhat clumsy arrangement of the experiments (for instance, there were no markers at the targets to show the impact of the bullets and thereby to correct faulty shots), the officers could not corroborate my law, although they conceded that the change of light had a marked influence on their shooting. They came to the conclusion that the light did not change the position of the center on the target, but influenced shooting results by the changed illumination only of the front-sight. They neglected the fact, that my front-sight, inclosed in a dark, one-inch cylinder, *G*, was not subjected to the direct rays of the sun, the whole gun being besides shaded by the roof of our shooting hall. The regular army rifle, excellent a weapon as it otherwise is, has no movable sight, to determine the side deviations, the front-elevation being changed by a very coarse adjustment. My opinion is that the army-rifle and army target, with its gross subdivision, are not the proper means to investigate such fine changes with. The gentlemen of the commission, from a great number of wrong and ill-directed bullet-marks on the target, constructed a semicircular line, but in reverse direction of that I expected them to find. Instead of the curve, *H*, by unchanged sights and unchanged position of the gun they found a curve like *J*. But nevertheless, with great satisfaction I have seen from their report, which was sent to me by order of the Secretary of War, that as a result of the last forty shots late in the evening the mean of all their hitting marks was high right and not low left, as their curve would indicate. Col. Michie, professor of philosophy, United States Military Academy (West Point), after careful researches with a heliostat and aiming experiments, but without real shooting trials, came to results decidedly favorable to my theory.

Here the matter rests, as far as the United States army is concerned. Being an old man, who has put his rifle aside long ago, I really would be very happy if this so-called law of the apparent change of the bull's eye could be either verified or proven to be a false assumption only. This seemingly changed position of an object under the changing influence of the light can not, as I believe, be produced by simple laws of refraction, or by the changing temperature of the air near the surface of the earth, or by changing barometric pressure, as is proven by the sudden change of position when the sun breaks through a cloud. It cannot be a phenomenon similar to the *fata morgana*, because the shooter would have to lower his gun, for instance, at noon-time, instead of elevating it as he has to do now.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE NEW DEPARTMENT OF COMMERCE.

THE new Department of Commerce will have the distinction of dealing with the largest commercial interests of the world. In domestic exports, in manufactures, in transportation, and in internal commerce the United States is at the head of the world's list of great nations. Some figures just compiled by the Treasury Bureau of Statistics, which by the new law becomes a part of the Department of Commerce, estimate the internal commerce of the country at twenty billions of dollars, or equal to the entire international commerce of the world.

In arriving at this estimate of $20,000,000,000 for the internal commerce of the United States, the Bureau of Statistics includes only one transaction in each article produced, while, in fact, a very large number of the articles produced pass through the hands of several "middlemen" between those of the producer and those of the consumer. The estimate is based upon the figures of the census, which put the total value of manufactures in 1890 at $13,000,000,000; those of agriculture, at nearly $4,000,000,000, and those of minerals about $1,000,000,000. Adding to these the product of the fisheries, the total value of the products of the great industries in 1900 would be $18,000,000,000, and the rapid growth in all lines of industry since 1900, especially in manufacturing, seems to justify the conclusion that even a single transaction in all the products of the country would produce an aggregate for 1902 of fully $20,000,000,000.

Estimating the internal commerce of the country at former census years by the same method, the Bureau of Statistics finds that the total internal commerce has grown from about $2,000,000,000 in 1850, $3,500,000,000 in 1860, $6,250,000,000 in 1870, $7,750,000,000 in 1880, and $12,000,000,000 in 1890. It will be seen from this that the internal commerce seems to have increased 50 per cent in the decade from 1890 to 1900, and is ten times as large in 1902 as in the year 1850.

During the same period, from 1850 to 1902, the population has increased from 23,000,000 to 79,000,000, and is therefore only 3½ times as great as in 1850, while the internal commerce is 10 times as great as at that time. This relative gain of internal commerce over population is due, in part, to the greatly increased facilities for transportation, the cheapening of cost of articles utilized, and the increased earnings and increased wealth of the people. The railroads have in-

creased from 9,021 miles in 1850 to 201,839 miles in 1902, and the estimated wealth of the country from \$7,135,780,000 in 1850 to \$94,300,000,000 in 1900—a per capita increase of from \$308 in 1850 to \$1,236 in 1900. This increase in wealth has been accompanied by an increase in deposits in banks, those in savings banks alone increasing from \$43,431,130 in 1850 to \$2,597,094,580 in 1901.

Meantime the foreign commerce has made rapid increase, though not at a rate of speed proportionate to that of internal commerce. The imports of 1850 were \$173,509,526; those of 1902, \$903,320,948. The exports in 1850 were \$144,375,726; in 1902, \$1,381,719,401.

While it is not practicable to measure the internal commerce of other countries with the same accuracy as that of the United States, it is known that in agricultural products, manufactures, and minerals the United States now outranks the other nations of the world, and that the transactions in these products, which form the internal commerce, may therefore be assumed to surpass those of any other country. The manufactures of the United States are now about double those of the United Kingdom and nearly equal to those of France, Germany and Russia combined, while the value of the agricultural products of the United States far exceeds that of any other single country.

CRYSTALLIZED PEROXIDE OF HYDROGEN.

By WILHELM STAEDEL.

THE firm of E. Merck has been supplying a solution of peroxide of hydrogen at 30 per cent for some years past; this peroxide fulfills all our requirements as regards purity and stability. This preparation is appreciated as an antiseptic, more especially in connection with surgical instruments and appliances. They have been able to manufacture also a sufficiently concentrated solution on a large scale. The author of this article is indebted to the courtesy of this firm for large quantities of the latter product for the purposes of research.

This research is not yet completed, but it is possible, nevertheless, to announce one fact chosen from among the most interesting ones observed, viz., that peroxide of hydrogen, contrary to recent assertions, crystallizes with ease, and in a very distinct manner. Its melting point appears to be about —2 deg., but it may be possibly a little higher. The preparation used contained from 95 to 96 per cent of H_2O_2. In a freezing mixture at —20 deg. it remained liquid; in a mixture of ether and solid carbonic anhydride it solidified into a hard resisting mass. Further, this phenomenon also occurred in chloride of methyl. The eutectic point thus appears to be between —20 deg. and —23 deg. If we throw a trace of the solid peroxide into the liquid cooled down to —8 deg. or —10 deg., there immediately form magnificent needle-shaped crystals, as transparent as water, and which soon permeate the whole mass. By draining the mother-liquor from the crystals and allowing these to regain their liquid state by fusion, we can obtain, by means of a second crystallization, peroxide of hydrogen free from water.

Repeated analyses have given the composition of these crystals as 100 per cent H_2O_2. Similar crystals can be obtained from more dilute solutions titrating 90 or even 80 per cent of H_2O_2. It seems that practically we may look upon it as possible to prepare a pure peroxide of hydrogen without having recourse to an operation which is not always free from danger; that is to say, to the distillation of high percentage solutions, as done by Wolffenstein and Brühl, or Spring, to obtain anhydrous peroxide of hydrogen.

For the better manifestation of the most marked properties of peroxide of hydrogen, a series of experiments was devised. Thus, an extremely small quantity of platinum black produced a catalytic decomposition accompanied by a violent explosion; powdered binoxide of manganese, or a mixture of carbon and powdered magnesium with a trace of binoxide of manganese, takes fire immediately when put in contact with anhydrous peroxide of hydrogen, or thrown into its solution at 90—95 per cent. Finely divided iron (reduced iron) alone is without action; the liquid simply mixes with the powder, but if we add now a little binoxide of manganese a flame is produced, and the iron burns, throwing off sparks. Powdered lead becomes inflamed in the same manner. A few drops of anhydrous peroxide of hydrogen thrown on to wool or a moist sponge immediately bursts into flame.

Monohydrated sulphuric acid can be mixed with anhydrous peroxide of hydrogen if it is done at a low temperature.

The refrigeration must be sufficient to counteract the evolution of heat which takes place. If the operation is not conducted under these conditions, oxygen very rich in ozone is given off. The examination of this reaction is not yet complete; it may be possible to produce per-sulphuric acid by these means.

We can also make use of peroxide of hydrogen in two reactions. The most interesting one, that is to say, that of which the best use can be made, takes place with sulphate of titanium. By its help we are able to detect 1 part of peroxide of hydrogen in solution in 1,800,000 parts of water. When the ratio is only 1 : 18,000 the reaction is manifested by the appearance of a deep yellow coloration, becoming bright yellow for 1 in 180,000, and remaining yellowish in a fairly thick layer with 1 part in 1,800,000. The action on ceric sulphate and ammonia is less sensitive; it reaches its limit of sensitiveness when the solution is diluted to 1 in 180,000. It must also be remarked that if the solutions in which we have produced the titanium reaction are still colored after several days, this cannot be said of the cerium solutions, which in a very few days become completely colorless.

We know that peroxide of hydrogen is capable of forming crystallized compounds with metallic salts. M. Tanatar has described some of these bodies. The compound containing cadmium lends itself very well to the demonstration. On pouring a 90—95 per cent solution of peroxide of hydrogen into a concentrated solution of chloride of cadmium the mass becomes thickened by the formation of small, fine, white silky flakes. When collected and dried it has been found that they contained about 23 per cent of peroxide of hydrogen.

It may be concluded from the above that the problem of the preparation of anhydrous peroxide of hydrogen on the large scale has been solved. The economic results of this achievement will be known to us in the future. But from the point of view of facts already known, we may say with safety, that the use in surgery of an antiseptic product incapable of introducing foreign matters into wounds, or of producing anything besides water and oxygen by its decomposition, is made practicable by the present preparation; we are perfectly justified in hoping for great results in this direction.

In conclusion, we may remark that anhydrous peroxide of hydrogen, prepared by means of crystallization, appears to be easily transported. A well-packed sample was placed on a truck and sent on a journey of 50 or 60 kilometers, without undergoing any change. A second sample was treated in the same manner for three days without experiencing any injury.—Zeitschrift für Angewandte Chemie.

THE RADIO-ACTIVITY OF URANIUM.

By FREDERICK SODDY.

DURING the course of the investigation contained in the preceding paper on the radio-activity of thorium, it became advisable to investigate in parallel a radioactive element that does not give out an emanation, or excite radio-activity upon surrounding bodies. It has been shown that these secondary actions always form a possible factor in the results obtained with thorium. For this purpose the radio-activity of uranium was chosen, but at the outset great differences arose between the results obtained and those published in the same field by prior investigators. These differences led to a comparative study being made in certain cases of the photographic and electrometer methods of measuring uranium radio-activity, which resulted in explanation of the anomalous results that had been obtained.

Sir William Crookes (Proc. Roy. Soc., 1900, p. 409) made the beautiful discovery that in one chemical operation uranium could be obtained inactive to the photographic plate, while the whole of the inactivity was concentrated in a small non-uranium residue. This residue, to which he gave the name UrX, was at least a hundred times more active than the uranium from which it had been separated.

On repeating this separation, which consists in precipitating solutions of uranium with ammonium carbonate, and re-dissolving the precipitate in excess of the reagent, it was found that the small residue of UrX was almost inactive, while the uranium, contained in the ammonium carbonate filtrate, possessed about the normal amount of activity. The electrical methods of Prof. Rutherford were employed for measuring radio-activity. The same negative result was obtained by the other method of separation employed by Crookes. If crystallized uranium nitrate is dissolved in ether, the uranium divides itself in two unequal fractions between the ether and water present. That dissolved in the ether layer, which is the major fraction, was found by Crookes to be inactive to the photographic plate, while the small part dissolved in the aqueous layer possessed all the activity contained in original uranium nitrate. But as in the former case, on repeating the operations, both fractions appeared almost equally active to the electrometer, and no separation had apparently been effected.

The same preparations were then examined for their action on the photographic film, and gave results exactly the converse of those observed with the electrometer and in accord with the published results of Sir William Crookes.

Rutherford (Phil. Mag., 1899, p. 109) showed that uranium radiation consists of two different types, which he named the α and β radiation. The α is absorbed very readily even by gases, being reduced to half value by passage through 4.3 mm. of air. The β, on the other hand, is very penetrating in character, and is but little absorbed by gases. It is able to pass through 0.5 mm. of aluminium before it is reduced to half value. This latter part constitutes only a few per cent of the total radiation of the uranium. In addition, by the electrometer method of measurement under ordinary circumstances, a fraction only of the intensity of the β radiation is recorded, for this method depends upon the ionization of the air, and this is proportional to the absorption of the rays by the air. It follows, therefore, that under ordinary circumstances, in which the rays traverse a few centimeters only of air, that the electrometer method measures practically the α radiation of uranium alone. The photographic method employed by Crookes, in which the rays are made to pass through glass or card before reaching the sensitive film, will, on the other hand, measure only the β radiation. Hence the results obtained would be explained if the methods employed separated the β radiation only and left the α radiation intact.

Becquerel has shown (Comptes Rendus, 1900, cxxx., p. 1,584) that the rays from uranium are deflected in the magnetic field, and therefore consist of cathode rays. Rutherford and Grier (Phys. Zeit., 1902), in a general investigation of the rays from various radioactive substances to determine what proportion in each case was deviable in the magnetic field, and therefore cathodic in nature, had already at this time shown that the β radiation of uranium is entirely cathodic, and the α radiation not at all. They undertook the examination of the specimens that had been prepared in the course of the present work, the details of which appear in their paper with the special apparatus employed. It suffices to state here that in the arrangement they adopted the rays are made to pass through a sufficient thickness of air to absorb a considerable part, and the sensitive Dolezalek electrometer was employed. Under these circumstances UrX was found to be giving out ionizing rays abundantly. This radiation was shown to be the β radiation of uranium only, practically free from α, for it passed through aluminium foil without great loss, and is deviable to the same extent by the magnetic field. The rays from the photographically inactive uranium were found, on the other hand, to consist entirely of α radiation, and gave no rays deviable in the magnetic field, or capable of passing through thin aluminium foil. I must here express my great obligation to Prof. Rutherford and Mr. Grier for permission to use these results.

It thus appears that the methods of chemical separation employed by Crookes effect a separation only of the constituent responsible for the β radiation. The uranium after the process still retains the whole of the non-deviable radiation, which in the electrometer method contributes the greater part of the effect. In this respect uranium is analogous to thorium, as shown in the preceding paper. But the excited radioactivity produced by ThX as a secondary effect, which itself comprises both deviable and non-deviable radiation, makes it impossible at present to say whether the primary radiation of ThX is, like that of UrX, wholly cathodic or not. The non-separable parts in both cases consist entirely of rays non-deviable in the magnetic field.

The next point to be decided was whether the α radiation of uranium could affect the photographic plate. A sample of the preparation free from β radiation was exposed about 5 mm. away from a sensitive film for seventy-two hours without intervening screen. Only a very slight darkening occurred, so that the action, if any, of the α radiation may be considered negligible in comparison to the effect of the β radiation. It is not possible to try longer exposures than three days by this method, owing to the regeneration of the β radiation which will be referred to later. However, Becquerel (Comptes Rendus, 1902, cxxxiv., p. 208) exposed plates for twenty and forty-nine days near uncovered uranium salts, in a magnetic field where the β radiation would be deflected and eliminated, and failed even after these long periods to obtain an impression on the sensitive film. He concluded that the whole of the uranium radiation is cathodic, and can be deflected by the magnetic field. But the foregoing considerations make it clear that the α or non-deviable radiation of uranium, which contributes the major part of the ionization effect, is without appreciable action on the photographic plate.

In light of these results, and those obtained for thorium in the preceding paper, the method employed by Becquerel (Comptes Rendus, 1900, cxxxi., p. 137) to separate the active constituent of uranium is of interest. M. Becquerel precipitated barium as sulphate in solutions of uranium, and found that after successive precipitation the activity of the latter was much enfeebled, both toward the electrometer and the sensitive film. As, however, he inclosed the salt in paper for the electrometer measurements, and this absorbs the α radiation almost or quite completely, the result must not be taken to mean that both the α and the β radiations were separated by the process. On repeating the separation it was found that, as in the case of the methods of Crookes, the β radiation only was removed. After four successive precipitations in one day, the β radiation was found to be reduced to 8 per cent of its original value, and eight more precipitations on the day following completely removed it. But the activity of the resulting uranium preparation to the electrometer under ordinary circumstances was hardly appreciably decreased. The α radiation had therefore not been affected.

Becquerel has already shown (Comptes Rendus, 1901, cxxxiii., p. 977) that the uranium after this treatment recovered its normal activity on standing. With the sensitive electrometer the presence of cathode rays in a product originally quite freed from them, can be detected after three days. It thus appears probable that what has been shown to hold true for ThX applies equally to UrX, and the subject is under investigation conjointly with Prof. Rutherford. The same question therefore arises for the non-separable activity of uranium already discussed for that of thorium.

1. Is this residual activity to be regarded as a secondary radiation produced by the presence of UrX?
2. Or, is it caused by a distinct material substance capable of chemical separation?

On the first view, if UrX—the cause of the phenomenon—is removed, the residual activity will decay with time. The following experiment was therefore performed: The solution of uranium nitrate which had been successively precipitated with barium sulphate twelve times, and had been shown to be free from β radiation, was allowed to stand. Every three or four days it was once more precipitated in the same manner, and the UrX produced during that period removed from the uranium. After twenty-one days, the uranium in the solution was precipitated with ammonia and converted into the green oxide. For comparison, a sample of the same uranium nitrate, as obtained from the maker, was subjected to two precipitations with barium sulphate to remove most of the β radiation, the uranium then being precipitated and converted into oxide as in the former case. The radiations from the two samples were then directly compared. In the one the α radiation had been given three weeks to decay, and by comparison with the other a direct measure of the diminution suffered during this period could be obtained. Not the least difference, however, could be detected in the intensities of the radiations in the two cases. The actual values obtained were within 1 per cent of each other. If it is assumed that in this experiment a difference of 5 per cent could be with certainty detected, the conclusion is arrived at that if the α radiation of uranium is a secondary phenomenon produced by the β, it takes at least a year to decay to half value. As this is not in accordance with what is known of the nature of excited radio-activity, the view cannot be regarded as probable.

On the second view, the irradiation is produced by a second distinct type of matter. But as in the case of thorium, all attempts made to separate such a constituent of uranium by chemical methods have so far failed, although the methods have not yet been exhausted. It is, however, interesting to note that polonium, discovered by Curie, fulfills in almost all respects the functions of this hypothetical constituent. It gives only non-deviable radiation, and Prof. Rutherford, to whom the suggestion is due, found that the penetration power of the rays from polonium is very

similar to that of the uranium radiation. Moreover, M. and Mme. Curie (Comptes Rendus, 1902, cxxxiv., p. 85) have stated that its activity slowly decays with time, which is to be expected *after*, but not before, it has been separated from the uranium producing it. However, experimental work has not yet justified this suggestion.

The actinium of Debierne, according to a recent paper by Crookes (Chemical News, lxxxv., p. 109), has been found to be identical with UrX, although no reference is given.

In the paper just quoted, Crookes brings forward some results obtained by the photographic method which led him to the conclusion that UrX gives a radio-active emanation similar to that given by thorium and radium. No evidence of such a radio-active emanation has been obtained in the course of the present work even with the most sensitive electrometer, and it appears probable that the cause of the darkening of the photographic plate by this body in the cases where the film is shielded from direct radiation, is not a radio-active substance in the accepted sense of the word, but an agent similar to hydrogen peroxide in its photographic actions.—Chemical News.

HOW SOME IMPORTANT RESULTS IN PLANT BREEDING ARE ACCOMPLISHED.*

By WILLET M. HAYS.

IN France and Germany sugar beets have been so improved by breeding that more than double the recoverable sugar is produced from an acre. The essential features of the plan are simple, direct, and effective, and may be briefly stated as follows: The varieties combining good yield of roots, high percentage of sugar, and low percentage of "solids not sugar" are selected for foundation stocks. A large field is planted to a given variety. The seeds are drilled in thickly and the young beets are thinned to a uniform distance, say, 7 inches, in rows 18 inches. When ripe, the plow is carefully run along the row to make pulling easy, and the beets are pulled and laid beside the row. Careful workmen now select all smooth, nicely formed beets of medium size (weighing 1½ to 2 pounds) which have grown well down under ground, and preserve them in pits in the field until the weather is so cold as to endanger them, when they are stored in deep pits, or in cool cellars (sometimes they are packed in sand), where they remain until near planting time. Before the rush of spring work, chemists, aided by laborers, analyze a sample of juice from each beet. With a small boring machine, a core of pulp is bored out of each root at a point near its center. The juice pressed from this pulp is strained, tested for its specific gravity, and clarified and tested by means of the polariscope for its percentage content of sugar. All roots which fall below a fixed standard of percentage of sugar content and purity of juice are discarded and fed to animals. The roots which prove best are assorted into classes, that is, those having, respectively, 15, 16, 17, and 18 per cent or above of sugar. Each lot is planted out by itself, and the seeds grown from the best roots are sold for a higher price than seeds from those which test lower. Where the breeding is done carefully, the roots in the lot having the highest percentage of sugar with high purity are so planted that each plant will have a given area of soil, say, 15 by 20 inches, that it may be compared with each other plant of its class. The yield of seed of each of these plants is recorded, and saved in a separate packet bearing the number of the mother plant. The third year the seeds of each of the many mother plants are planted in separate rows. When the beets are ripe for the sugar harvest, the yield, the average weight per plant, and the quality as to form, depth underground, etc., are recorded, and samples representing an average of each centgener† row from each mother beet are analyzed to get a measure of her centgener power in producing rich, pure juice. All stocks from mother plants making fair centgener records are used to produce seed, thus multiplying them into large quantities for sale for seed to farmers who grow beets for sugar factories. From among the beets of stocks making the highest record for their mother plants, large numbers of well-shaped roots of suitable size are chosen. These are analyzed, as were the beets first mentioned; the poor ones are discarded and the good ones are again graded into classes. The beets of the class highest in percentage content of sugar, high in purity, and rather large, again serve as mothers of centgeners, to be tested, and the best blood lines are again sought out to serve as the chosen basis for further improvement of the stock of beets. Since beets cross pollinate, hybridization and crossing are here potent factors, sometimes aiding and sometimes hindering the beet breeder. This rigid selection, long carried out, has resulted in the addition annually of one-eighth to one-half of 1 per cent to the sugar in the juice of sugar beets, and has decreased the impurities of the juice, thus making easier the manufacture of the sugar. This simple, effective plan, patiently carried out, has not only added many millions of dollars of wealth to the farmers, manufacturers, and transportation companies, but has given cheaper sugar to all civilized peoples.

The plan of breeding wheat at the Minnesota experiment station follows the same general lines long used by the breeders of sugar beets. Hundreds of varieties of wheats were secured from Minnesota and from other States and countries. Less than a dozen of these, after several years of trial, were chosen as the best for foundation stocks. To start anew during a given year, ten superior varieties, new and old, are usually chosen as foundation stocks. Two thousand or even 5,000 plants are grown of each stock. By means of a specially devised planting machine, two or three seeds are placed in each hill. The hills are 4 by 4 inches apart for spring varieties, and 5 by 5 inches apart for winter wheats; and when the plants are a few inches high they are carefully thinned to one plant in a hill. The plats of wheat are kept carefully cultivated and free from weeds, so that each plant may have the same amount of room and the same opportunities as each of its fellows. When ripe, sheep shears are used in removing from the plat all but those plants which appear especially vigorous and heavy yielders of grain. About 5 per cent (100 out of 2,000 of each variety, or 1,000 out of the 20,000 of the ten varieties) are thus retained. The spikes of each of these are cut off and placed in a separate packet bearing the number of the mother plant. These are tested on small scales, and any of insufficient weight are discarded. The 50, more or less, remaining of each lot are now shelled and their net weight is recorded, as is also their quality, as determined by inspecting the seeds. The 10 yielding heaviest and showing superior grade of grain from each of the 10 foundation varieties, 100 in all, are now selected as mothers of nursery stocks. The second year 100 plants, called for convenience a centgener, from each of the 100 mother plants chosen as above, are similarly grown in the nursery plats. The entire centgener plat is now harvested by pulling the plants. To correct for hills containing no plants, a record is made of the exact number harvested. From each of a dozen of the strongest appearing plants a spike is chosen to supply seeds for a similar centgener plat the third year. By

NURSERY IN WHICH CENTGENER PLATS OF FLAX AND BEANS ARE ALTERNATED TO INSURE AGAINST TOO MUCH CROSS POLLINATING OF NURSERY STOCKS OF FLAX.

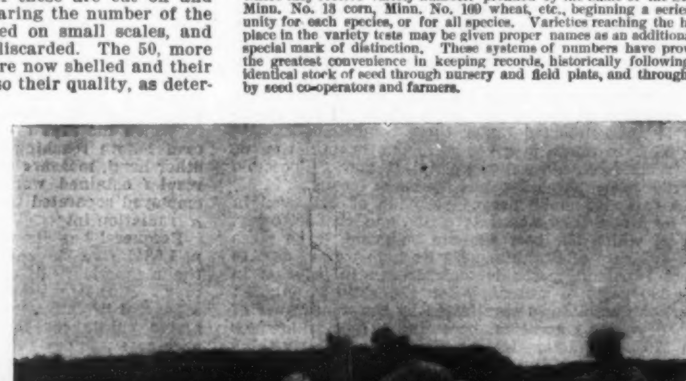
means of specially designed thrashing and cleaning machinery the seeds from the bundle are now separated. The weight of the thrashed seeds, plus the weight of those from the dozen chosen seed spikes, is divided by the number of plants actually harvested from the plat, thus giving the average yield per plant of each plat. These centgener trials are repeated for two more years, when the average yield per plant from each of the 100 mother plants may be compared. Those which yield highest and have had good average appearance or grade are now singled out and tested as to their percentage content of nitrogen, the quality of their gluten, and other qualities desired in milling wheats, or in macaroni wheats, as the case may be. Those nursery stocks (heretofore about one-third, or 30 out of the 100) which prove superior in the nursery and laboratory tests, are now increased during the fifth year so as to have sufficient seed for a field plat. Here the new varieties are given a practical field test, beside all the standard and the other best new wheats. Here, during the sixth, seventh, and eighth years since starting to secure the blood of superior mother stocks, each nursery stock * (now honored with a number for a variety name, as Minn. No. 163 wheat) is grown in the field beside its parent variety and other varieties competing for prominence. Any variety which here gains a very high record for yield and quality is sent to be tested by co-operating experiment stations, and is given rigid milling, baking, and chemical tests. If it

* From Yearbook of United States Department of Agriculture, 1901.

† *Centgener*, combining the root words of centum, hundred, and genera, generation, a hundred more or less (a large number) with a common parentage, is a word devised to aid in comparing the prepotency and breeding values of parents used in breeding by comparing the averages of a large number of the progeny of the respective parents. *Centgener power* means nearly the same as prepotency, as used in animal breeding, but is better adapted to use in hermaphroditic plants, with the male and female parents a single plant. The term *Centgener tests* may be usefully applied to breeding animals as well as to mother plants. The owner of twenty trotting-bred mares having the choice of breeding them to a stallion with a record of 2:10 with many colts with records of 2:30, or to another stallion with a record of 2:30 but with many colts with records of 2:10 would at once choose the sire showing the best ability to get fast horses. The breeder of wheat, once he has under comparison the average yields for three years of plats of 100 of the progeny of the respective mother plants, pays little attention to the individual yields of mother plants. Centgener measures of mother plants or of breeding animals are much safer guides to their values as parents of improved strains than are measures of the individual qualities of parents.

* The term *nursery stocks* is applied to the progeny of a few mother plants, or in some cases of only one, used as the mothers of newly bred stocks in the plant-breeding nursery. It has been found convenient to class them by the years in which they were started in the nursery, and to use the Roman character I to designate originated by selection alone, and II, originated by hybridizing followed by selection. Thus, 25 stocks of wheat originating by selection in 1901 are designated as I-1901, 1; I-'01, 2, etc., and 45 hybrid wheats originating from flowers cross pollinated in 1899 are designated as II-'99-1, 2, 3, etc. Nursery stock numbers are literally names of new varieties so long as they remain in the breeding nursery. Only the few which there prove best are taken to the larger field plats, where they receive variety numbers prefixed by the name of the State, as Minn. No. 13 corn, Minn. No. 169 wheat, etc., beginning a series with unity for each species, or for all species. Varieties reaching the highest place in the variety tests may be given proper names as an additional and special mark of distinction. These systems of numbers have proven of the greatest convenience in keeping records, historically following each identical stock of seed through nursery and field plats, and through trials by seed co-operators and farmers.

STUDENTS RECORDING THE HEIGHTS OF WHEAT PLANTS CHOSEN FOR MOTHERS OF CENTGENERS.



MACHINE FOR THRASHING CENTGENER PLATS OF WHEAT, WITH PLATS PLANTED TO INCREASE NEW VARIETIES TO QUANTITIES SUFFICIENT FOR FIELD TESTS.

runs the gauntlet as a superior wheat in the several States and in the mill and laboratory, its candidacy for wide distribution is accepted. Trained seed growers, preferably graduates of the school of agriculture, and other good farmers are chosen in each locality to become the experiment station's local seed disseminators, called seed co-operators. The seeds are sold in quantities to plant small fields to these co-operators at 50 to 100 per cent above the market price of common grain, and these co-operators are expected, especially if they wish to be again thus chosen, to raise and sell to their neighbors for seed large quantities of the new variety. A sufficient number of reports are required from these co-operators, so that the experiment station may know how the new variety is holding up in yield with the wheats commonly grown in each portion of the State. All facts are freely advertised, so that the growers may know which variety is finally giving the largest returns per acre. Quantities of each new variety as distributed are also sold to seed dealers, that they also may increase it and widely distribute it. One variety, Minn. No. 163, has been thus widely and successfully distributed, and another, Minn. No. 169, is ready for dissemination for planting in 1902. It has been estimated that these two new varieties in only a few years will have repaid the State for all the money expended to date in plant breeding, including all the variety testing done by the station and substations.

MACHINE FOR THRASHING CENTGENER PLATS.

THE SCIENTIFIC ASPECT OF MODERN MEDICINE.*

By FREDERIC S. LEE.

THE origin and development of medical science are contemporaneous with the origin and development of mankind. So long as man has been, so long has been disease; and whenever man has suffered, man has tried to heal. The foundations of medicine lie deep in that soil of common knowledge from which arose all the sciences, and throughout its history it has freely absorbed the discoveries of them all. From the first it has been, and it must ever remain, their common meeting-place. In proportion as its spirit and its methods have been scientific it has progressed toward ultimate perfection. Yet, notwithstanding the importance of science to medicine, from first to last medicine has been permeated by the pernicious influence of empiricism. A wise man once said that all true science begins with empiricism, and medical science is a striking example of this fact. But it made an early effort to free itself. The most brilliant epoch of Grecian history is marked no more immortally by the wisdom of Socrates, the histories of Herodotus, the tragedies of Æschylus, and the art of Phidias, than by the medicine of Hippocrates and his followers, for this represents the first recorded endeavor—and a mighty endeavor it was—to break away from the empiricism of the earlier ages. But the science of the time was meager, and, however laudable the aim, the Hippocratic writings are full of empirical notions. From that time on, down through the ages, we find science and empiricism, like the good and bad principles in all natures and all religions, ever contending. And the struggle still continues. As Richard Hooker wrote more than three hundred years ago, so to-day do "Empirics learn physic by killing of the sick." The empiricism of to-day is not solely the method of osteopaths, Christian scientists, and vendors of patent nostrums; it is found in the schools and practice of legitimate medicine. At times it has surprising successes; but the struggle is an unequal one, and science is sure to be victorious. At no period of the world's history has the scientific idea in medicine been so aggressive and advanced so rapidly as during the past fifty years, and at no time has it seemed nearer its ultimate victory than at this beginning of the twentieth century. This advance is so striking and so full of general interest that I have ventured to choose it as my subject to-day, under the title of "The Scientific Aspect of Modern Medicine."

The Idea of a Vital Force.—One of the most essential prerequisites of this advance was the complete and final liberation of medical science, and of all those sciences now comprehended under the general title of biology, from a burden which in one form or another had hampered progress from the earliest times. I mean the conception that living bodies possess within themselves an active force or principle, differing in nature from anything possessed by non-living bodies, and which represents the vitality of living things. The beginnings of this idea are found in the various forms of animism of savage races, according to which a spirit or ghost inhabits the body and is responsible for its actions. In diseased states, this good spirit is dispossessed by an evil one. In one form or another this belief is met with among all civilized peoples. It is found in the days of Salem witchcraft, and even as late as 1788, in Bristol, England, when seven devils were exorcised from an epileptic. In physiology, from the times of the early Greek medicine until after the Renaissance, the animistic idea is represented by the doctrine of the *pneuma*, or the "spirits." In Hippocratic times the spirits entered the body through the lungs, were carried by the blood to all parts, and enabled the vital actions to take place. At about 300 B. C. the Alexandrians found it convenient to make use of two forms of this mysterious agent, the "vital spirits" residing in the heart, and the "animal spirits" in the brain. To these, in the second century of the Christian era, Galen added a third, the "natural spirits," located in the liver.

All physicians of the present day are familiar with the remarkable story of Galen and his long reign in medicine. Born in the time of the Emperor Hadrian, he lived an active life of medical research and practice. He was the imperial physician of Rome, and while the wise Marcus Aurelius was writing his "Meditations," Galen was producing his numerous medical books. These covered the whole field of the medicine of his time, much of which was the direct result of his own investigations. His activity was unparalleled, his knowledge immense, his logic and literary skill pronounced, and his system of medicine all-embracing. In these respects he was far above his contemporaries, and with the decline of the Roman civilization, the consequent disappearance of originality of thought, and the long unbroken sleep of research, what wonder is it that his brilliance should shine unrivaled through the dark ages?

For more than a thousand years following the death of Galen, his authority in all things medical was supreme, and the doctrine of the *pneuma* was unchallenged. Only when there came the intellectual awakening of the Renaissance did men ask themselves whether Galen's books or the human body more nearly represented the truth. But it was even long after this that the *pneuma* was deposed, and when it fell it was only to give place to the *archæus* of that archcharlatan, Paracelsus, and to the *anima sensitiva* of the mystic philosopher, Van Helmont, and the melancholy pietist, Stahl. Through the latter part of the eighteenth and the early part of the nineteenth century the vital principle was still in control of the physiologists, but, as they learned more of the conservation and the transformation of energy in inanimate things, and more of the working of living bodies, the gulf between the inanimate and the animate gradually narrowed, and the supremacy of the laws of chemistry and physics in all things living became clearly recognized. It is true that at times in these latter days, sporadic upshoots of a neo-vitalism raise their tiny heads, but these are to be ascribed to the innate aversion of the human mind to confess its ignorance of what it really does not know, and they do not receive serious attention from the more hopeful seekers after truth.

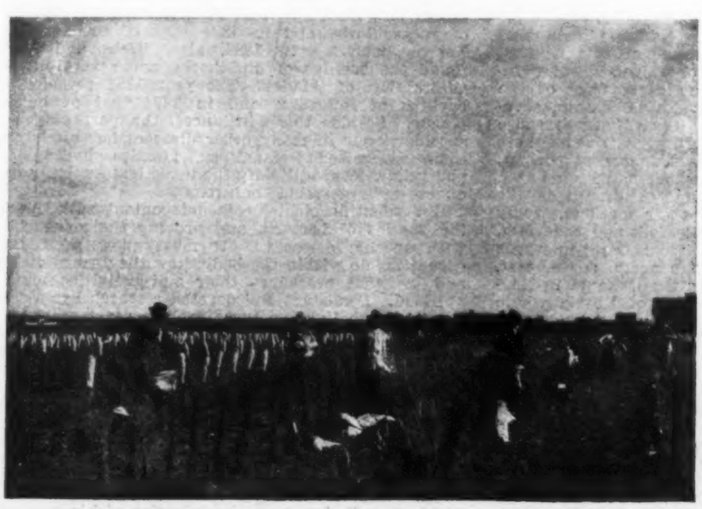
The elimination from scientific conceptions of the idea of vital force made possible a rational development of the science of physiology, and in this way led directly to the growth of a scientific medicine. In one of his luminous essays Huxley has written: "A scorner of physic once said that nature and disease may be compared to two men fighting, the doctor to a blind man with a club, who strikes into the melée, sometimes hitting the disease and sometimes hitting nature." . . . The interloper "had better not meddle at all, until his eyes are opened—until he can see the exact position of his antagonists, and make sure of the effect of his blows. But that which it behooves the physician to see, not, indeed, with his bodily eye, but with clear intellectual vision, is a process, and the chain of causation involved in that process. Disease . . . is a perturbation of the normal activities of a living body, and it is, and must remain, unintelligible, so long as we are ignorant of the nature of these normal activities. In other words, there could be no real science of pathology until the science of physiology had reached a degree of perfection unattained, and indeed unattainable, until quite recent times."

No period has been so rich in physiological discoveries as the last fifty years of the nineteenth century. Research has developed along two main lines, the physical and the chemical, and to-day physiology is rightly regarded as the foundation stone of the science of diseases, and thus as the basis of scientific treatment.

The Cell Doctrine.—At the time when vital force was having its death struggle, the cell doctrine was being born. Inseparably linked with the idea of the cell is the idea of protoplasm—protoplasm the living substance, the cell, the morphological unit. The heretofore mysterious living body is a complex mass of minute living particles, and the life of the individual is the composite life of those particles.

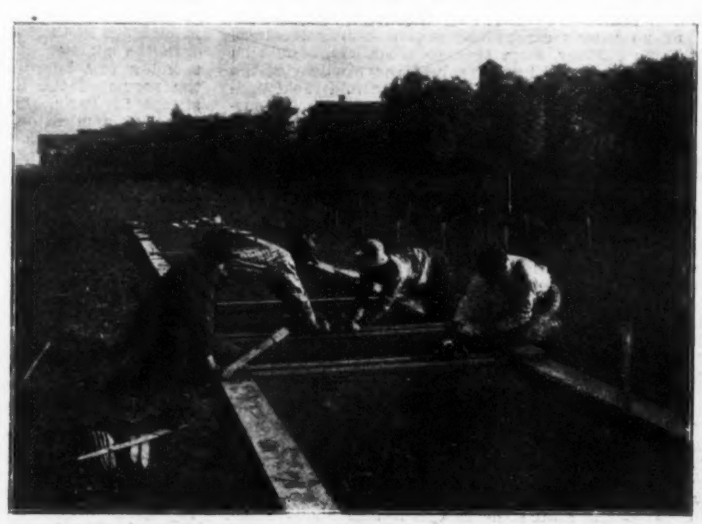
Within the past few weeks the world has bowed in mourning over the bier of an aged man who, more than forty years ago, in the strength of his vigorous manhood, gave to medical science in a well-rounded form the best of the cell doctrine of his time. Rudolf Virchow need have performed no other service than this to have secured worthy rank among

* An address delivered before the School of Medicine at the quarto-centennial celebration of the University of Colorado, November 14, 1902.



WORKING IN THE CENTGENER PLATS.

When ripe all the plants in the centgener plats of wheat are pulled, placed in bundles, tied to the plat stake, and a strip of muslin 18 by 36 inches is wound about the heads to prevent loss by shelling or from sparrows.



PLANTING WHEAT IN THE PLANT-BREEDING NURSERY BY MEANS OF A NEWLY-INVENTED MACHINE.

This machine is somewhat larger than an iron jack plane and runs between two boards, the shoe making a furrow below. Nails every 4 or 5 inches apart in one of the boards work in notches in the seed disk and cause it to revolve and drop the seeds in hills.

the great men of medicine of the nineteenth century, for few books exercised a greater influence over medicine during that period than his "Cellular Pathology." From ancient times physicians had been divided into many camps regarding the cause of disease. One idea had been prominent for more than twenty centuries: The humoralists had maintained that pathological phenomena were due to the improper behavior or admixture of the liquids of the body, which were, in the original form of this theory, the four humors: blood, phlegm, yellow bile, and black bile. According to the solidists, on the other hand, the offending agents were not the liquids but the solids, and especially the nervous tissues. Both humoralists and solidists were excessively speculative, and the growing scientific spirit of the nineteenth century was becoming impatient of hypotheses that could not be experimentally proved. The times were ripe for new ideas. Virchow, soon after taking the professor's chair at Berlin which he held from 1856 until his death, gave to an audience largely composed of medical practitioners, the lectures which, more than all else, have made him famous among his professional brethren. His main thesis was the cellular nature of all the structures and processes, whether normal or pathological, of all organized beings, and his dictum, "*omnis cellula e cellula*"—a cell arises only from an already existing cell—is the keynote of his theories. With his microscope he demonstrated the cells in all the tissues of the body, whether normal or pathological, and he proved the origin of the morbid cells in the normal ones. As to processes, he maintained rightly that all parts of the body are irritable, that every vital action is the result of a stimulus acting upon an irritable part, and he claimed a complete analogy between physiological and pathological processes. Every morbid structure and every morbid process has its normal prototype.

Virchow's ideas aroused enthusiasm the world over, and were eagerly studied and largely accepted by progressive men of medicine. Time and research have corrected errors of detail, but no one now denies the cellular nature and physiological basis of pathological phenomena. These facts are fundamental to the understanding and treatment of disease, which is now universally regarded as the behavior of the body cells under the influence of an injurious environment.

Virchow's ideas regarding pathological formations are a fitting complement to the laws of the conservation and transformation of energy. In the living world, as in the non-living, the law of continuity holds good. There are no cataclysms, there is no new creation. Structure and energy, whether normal or abnormal, proceed from pre-existing structure and energy. Only such a conception can make possible a scientific medicine, and, since its promulgation, medical advance has been rapid.

The Rise of Bacteriology.—During the past half century, and largely during the past twenty-five years, that is, during the lifetime of this university, there has grown up a totally new science, comprising a vast literature and a vast subject matter, though dealing with the most minute of living things. This is the science of bacteriology. The achievements in this field have surpassed all others in their striking and revolutionary character, and bear both on the conception of the nature of a very large number of diseases, hitherto puzzling human understanding, and on their prevention and cure, hitherto baffling human skill. All other human deaths are few in number in comparison with those that have been caused by the infectious diseases. Occurring the world over, constantly with us, invading all homes, and keeping the death rate in cities perpetually high, at times they have swept, with the fury of a fiery volcanic blast, over large regions of the earth's surface, sparing few, and leaving in their train empty households and cities of death. Recent statistics have claimed that one of these diseases, tuberculosis, alone kills one-seventh of all the population of the world.

To what are these pestilential visitations due? Many have said, "To the anger of offended gods;" others, "To the displeasure of a divine Providence;" the early physicians, "To a wrong admixture of the humors;" the later pathologists, "To mysterious fermentations." But none of these answers has touched the vital point. This was reserved for a simple, modest and earnest student of science, of humble origin, the son of a French tanner, a man unhampered by medical tradition, seeking only the truth, and possessed of no genius except the genius of perseverance. To Louis Pasteur, more than to all others, should be given the honor of having solved the problem of the causation of these dread diseases. He laid the foundations of the new science, broad and deep, with surprisingly few errors of judgment.

It is instructive to look at the leading features of Pasteur's life-work. From the beginning of his career, Pasteur was the defender of pure science, yet his work demonstrates well the ultimate practical value of what seems at first purely scientific. At the age of thirty-one he became a professor and dean of the Faculty of Sciences at Lille, and in his opening address he said to his students: "You are not to share the opinions of those narrow minds who disdain everything in science that has not an immediate application." And then he quoted that charming story of Benjamin Franklin, who when witnessing a demonstration of a scientific discovery, was asked: "But what is the *use* of it?" Franklin replied: "What is the use of a new-born child?"

Pasteur's various scientific labors form a strikingly connected series, each being logically bound to those that preceded it. Beginning with a study of the forms and significance of the crystals of certain salts, in which he made use of fermentation processes, he passed directly to the study of fermentation itself. He early appreciated the fact that this phenomenon, due as it is to the presence in fermentable liquids of microscopic living bodies, bears significantly on fundamental physiological processes; and his labors directly established the germ theory of fermentation. Fermentation led to his famous investigation of the problem of spontaneous generation, which for ages had vexed the scientific and popular mind. Organic liquids exposed to air soon become putrid and filled with microscopic beings, the origin of which was a mystery. Many believed them to originate spontaneously; others thought that the air contained a mysterious creative influence. "If in the air," thought Pasteur, "let us find it;" and by the simple device of stopping the mouths of flasks of sterilized liquids by a bit of cotton-wool, he was able to filter out the influence and keep his liquids pure and free from life. At the end of a year's active work he announced a most important fact: "Gases, fluids, electricity, magnetism, ozone, things known or things occult, there is nothing in the air that is conditional to life except the germs that it carries." His position was assailed by clever men, and he was forced to defend himself. It was here that his power of perseverance first formidably asserted itself. The struggle lasted for years, and Pasteur repelled each attack, point by point, with facts acquired by ingenious experimentation, with the ultimate result of giving to the doctrine of spontaneous generation its death blow.

Fermentation and spontaneous generation prepared Pasteur for his next victory. The French wine trade was threatened with disaster. Wines prepared by the accepted methods often became sour, bitter or ropy. It was said that they suffered from diseases, and the situation was critical. It was Pasteur's achievement not only to prove that the diseases were fermentations, caused not spontaneously but by microscopic germs, but also to suggest the simple but effective remedy of heating the bottles and thus destroying the offending organisms.

It seemed a long step from the diseases of wines to the diseases of silkworms, yet when a serious epidemic, killing the worms by thousands, threatened irreparable injury to the silk industry, it was only natural that Pasteur, with his growing reputation for solving mysteries by the diligent application of scientific method, should be called upon to aid. He responded with his customary enthusiasm, and for five years diligently sought the cause of the trouble and the cure. Though stricken by paralysis in the midst of his work, in consequence of which for a time his life hung in the balance, in three months he was again in his laboratory. Here, as in his previous labors, he achieved final success. He proved that the silkworms were infested with distinct diseases, due to easily recognizable germs. Furthermore, he devised efficient methods of eliminating the diseases, and thus he relieved from its precarious condition the silk industry of France and of the world.

By the year 1870 Pasteur's success had already assured him, at less than fifty years of age, a commanding place in the scientific world. His demonstrations of the all-important parts played by microscopic organisms in the phenomena which he had studied, had stimulated widespread investigation. He had already dreamed of the germinal nature of human diseases; and now medicine, which had long suspected them to be associated with fermentation processes, began to appreciate the significance of the new discoveries. In 1873 he was elected to fill a vacancy in the French Academy of Medicine, and from that time on he gave more exclusive attention to pathological phenomena. He investigated septicemia, puerperal fever, chicken cholera, splenic fever, swine fever, and lastly rabies. To speak at length of what he accomplished in this field would require much time. I would, however, mention one salient incident.

One day chance revealed to him a unique phenomenon, the further study of which led to one of his most significant discoveries. In the inoculation of some fowls with chicken cholera, not having a fresh culture of the germs, he used one that had been prepared a few weeks before. To his surprise, the fowls, instead of succumbing to the resultant disease, recovered, and later proved resistant to fresh and virulent germs. This was the origin of the pregnant idea of the *attenuation*, or weakening, of virus, which, nearly a hundred years before, Jenner unknowingly had demonstrated in his vaccinations against smallpox, and which had been employed by physicians in all the intervening time. By various methods of attenuation Pasteur succeeded in producing vaccines from the virus of several diseases, and he perfected the process of vaccinating animals and thus protecting them from attacks of the disease in question.

The story of Pasteur's brilliant investigations of hydrophobia is too recent and too well known to relate here. They form a fitting ending to a life rich in scientific achievement, stimulating to research, and momentous in the history of scientific medicine.

In the summer of 1886 it was my good fortune to spend a few hours in the presence of this man in the rooms of the then newly organized Pasteur Institute in Paris. It was in the early days of the practical application of the results of his long-continued, devoted experimentation regarding the cause and treatment of hydrophobia. In a large room there was gathered together a motley company of perhaps two hundred persons, most of whom had been bitten by rabid animals. Men, women, and children, from the aged to babes in the arms of their mothers, richly dressed and poorly dressed, gentle folk and rude folk, the burgher and the peasant; from the boulevards and the slums of Paris, from the north, south, east, and west of France, from across the Channel in England, from the forests and steppes of Russia where rabid wolves menace, from more distant lands and even from across the seas—all had rushed impetuously from the scene of their wounding to this one laboratory to obtain relief before it was too late. All was done systematically and in order. The patients had previously been examined and classified, and each class passed for treatment into a small room at the side; first, the newcomers, whose treatment was just beginning; then, in regular order, those who were in successive stages of the cure; and, lastly, the healed, who were about to be happily discharged. The inoculations were performed by assistants. But Pasteur himself was carefully overseeing all things, now assuring himself that the solutions and the procedure were correct, now advising this patient, now encouraging that one, ever watchful and alert and sympathetic, with that earnest face of his keenly alive to the anxieties and sufferings of his patients, and especially pained by the tears of the little children, which he tried to check by filling their hands from a generous jar of bonbons. It was an inspiring and instructive scene, and I do not doubt that to Pasteur, with his impressionable nature, it was an abundant reward for years of hard labor, spent partly in his laboratory with test-tubes and microscopes, and partly in the halls of learned societies, combating the doubts of unbelievers and scoffers, and compelling the medical world to give up its unscientific traditions and accept what he knew to be the truth.

Modern Surgery.—The earliest practical application to human disease of the results of Pasteur's labors was made in the field of surgery. The horrors of the early surgery had been largely eliminated by the discovery of the anesthetic effects of chloroform and ether, and the possibility of their safe employment with human beings. But the successful outcome of an operation was still uncertain. No one could foretell when the dreaded septic blood-poisoning might supervene and carry off the patient in spite of the most watchful care. Many hospitals were only death traps, the surgical patient who was taken to them being doomed to almost certain death. The suffering of the wounded in our civil war was extreme, and during the Franco-Prussian war, the French military hospitals were festering sources of corruption, their wounded dying by thousands. To Pasteur, who realized only too well that the cause of death lay in the germs that were allowed to enter the wounds from the outside, this unnecessary suffering and death of so many brave French youths was a source of intense grief. Yet, notwithstanding his protestations and the urging of his views upon those who were immediately responsible, little good was then accomplished, for the French surgeons were slow to adopt new ideas.

In England Lister was more successful. Fired by Pasteur's discoveries regarding fermentation and putrefaction, he conceived the idea of using carbolic acid in the vicinity of the wound while an operation was being performed, for the purpose of destroying whatever germs might be floating in the air or adherent to the surfaces. This was employed successfully, and at once the mortality of surgical operations was greatly diminished. This was the beginning of the aseptic surgery of the present day, and, in the light of what it has accomplished, Lister's achievement shines with brilliance. Carbolic acid was soon discontinued, owing to more efficient aseptic agents and methods of absolute cleanliness, but the essence of the modern surgical method is the same as at first, namely, to prevent the living germs from entering the wound. Septicemia and pyemia are no longer to be dreaded, the successful outcome of surgical procedure is practically assured, and operations that were undreamed of twenty-five years ago are now daily occurrences in the hospitals of the world. The most remarkable are those that come under the general head of laparotomy, which requires the opening of the abdominal cavity, and those performed on the brain. It may be said that the greatest development of scientific or aseptic surgery has occurred in America. Here the typical American traits of ingenuity, independence and courage have borne good fruit.

Disease Germs.—Pasteur's work was epoch-making. Apart from its revolutionizing the methods of practical surgery, it has completely changed our conception of the nature and the mode of treatment of the whole group of germ or zymotic diseases, and has gone far toward solving a host of long-existing and puzzling problems of general pathology. The actual discovery of the germs of human diseases and the proofs of their specific morbific properties did not fall within Pasteur's province. Such achievement has been the lot of others, most brilliant among whom is undoubtedly Robert Koch. The bacillus of anthrax, or splenic fever, was seen in 1838 by a French veterinarian named Delafond, but its part as the causative agent of the disease was first shown by Koch in 1876, this being the first conclusive demonstration of the production of a specific human disease by a specific bacterium. Think how recent was this event, so significant for the development of a scientific medicine and for the welfare of the human race! Koch's demonstration was made but twenty-six years ago, eleven years after the close of our civil war. But it was only after repeated subsequent experiments and the piling of proof on proof by Koch, Pasteur, and others that the new idea was generally accepted. Since then discovery has followed discovery, and the world watches eagerly for each new announcement. Koch acquired new laurels in 1882 by demonstrating the germ of tuberculosis, and in 1884 that of the terrifying Asiatic cholera. In 1884, also, Klebs and Löffler found the bacillus of diphtheria, and several investigators that of tetanus. The year 1892 revealed the bacillus of influenza, and in 1894 that of bubonic plague. Besides these instances, the part played by specific germs in many other diseases has already become recognized. Smallpox, measles, hydrophobia, and yellow fever still defy the investigators, but no one doubts their germinal nature.

But scientific medicine is not content with describing species of bacteria and proving their connection with specific diseases. It must show what these organisms do within the body, how they cause disease, and by what procedure their evil activities may be nullified. Persistent and devoted research has already thrown much light on these problems, yet so much is still obscure that it is difficult to generalize from our present knowledge. The germs find lodgment in appropriate places, and proceed to grow and multiply, feeding upon the nutrient substance of their host. In certain diseases, if not in all, their activities result in the production of specific poisonous substances called *toxins*, which being eliminated from the bacterial cells, pass into the cells of the host and there exert their poisonous effects. These effects vary in detail with the species of bacterium; and thus the individual, suffering from the behavior of his unwonted guests, exhibits the specific symptoms of the disease.

Preventive Medicine.—In looking over the history of the search for a means of cure, one is struck by the great value of the ounce of prevention. Keeping the germs out is in every way preferable to dealing

with them after they have once entered the body. This fact scientific medicine is impressing more and more deeply on the minds of public authorities and the people, and their response in the form of provisions for improved public and private sanitation is one of the striking features of the social progress of the present time. All the more enlightened nations, states, and cities of the world possess organized departments of health, which, with varying degrees of thoroughness, deal with the problems presented by the infectious diseases, in the light of the latest discoveries. Water and milk and other foods are tested for the presence of disease germs; cases of disease are quarantined; and innumerable provisions, unthought of fifty years ago, are now practised daily for the maintenance of the health of the people.

In the city of New York the Department of Health now undertakes, free of charge, examinations for the diagnosis of malaria, diphtheria, tuberculosis, typhoid fever and rabies. It treats all cases of rabies by the Pasteur method free of charge, and it supplies, at slight cost, diphtheria antitoxin and vaccine virus, besides mallein to aid in the diagnosis of glanders in horses, and tuberculin for similar use with suspected tuberculosis in cattle. Moreover, from time to time it issues circulars, intended for the education of physicians regarding the causation of infectious diseases and the newest methods of treatment; and through its officers and other physicians and by means of printed matter it endeavors to educate the people in matters of private sanitation. It requires official notification by public institutions and physicians of all cases, not only of the epidemic diseases, but even of tuberculosis. The benefits derived from these various prophylactic measures are seen in great decrease in mortality from the diseases in question. Much good is expected from the work of the newly-organized Committee on the Prevention of Tuberculosis of the Charity Organization Society of New York, which, backed by financial resources, is about to undertake an active campaign to lower the death rate from this particular disease, and to lessen the suffering and distress attributable to it.

Fifty years ago the term preventive medicine was unknown. To-day it represents a great body of well-attested and accepted principles. It has cleaned our streets, it has helped to build our model tenements, it has purified our food and our drinking water, it has entered our homes and kept away disease, it has prolonged our lives, and it has made the world a sweeter place in which to live.

Serum Therapy.—But if the ounce of prevention has not been applied or has failed, and the bacteria have forced an entrance into the body, what can scientific medicine do to cure? Two things are possible—the destruction of the destructive germs, and the neutralization of their poisonous toxins. The commonly recognized drugs here prove inefficient, for the simple reason that the amount of the drug sufficient to kill the bacteria is so great as to endanger the life of the patient. The most promising line of treatment has been suggested by the results of a study of the mutual relations of the bacteria and their hosts. Here again there are many gaps in our knowledge. It is not surprising that the cells of the body resent the intrusion of the barbaric horde of micro-organisms, with their poisonous offscourings. The cells are roused to unwonted activity, and pour forth into the blood specific substances, which, in many cases at least, seem to be of two distinct kinds, the *cytolysins* and the *antitoxins*. Of these, the cytolysins are destructive to the invading bacteria, while the antitoxins are capable of neutralizing, though in a manner not wholly clear, the toxic products of bacterial growth. Cytolysins oppose the bacteria, while antitoxins oppose the bacterial toxins, and the outcome of the disease depends on the relative efficiencies of the contending forces. If the invaders prove too powerful for the body cells, the individual succumbs; if the defenders prevail, he recovers.

With the picture of this natural conflict before the mind, medical science asked: "Is it not possible to aid the invaded body by providing it with weapons of the same kind as its own, but in larger quantity?" This question medical science has answered emphatically and affirmatively in the case of two serious diseases, diphtheria and tetanus, or lockjaw. By making a pure culture of their germs, and injecting their toxins into the bodies of animals, it can obtain a blood serum heavily charged with antitoxin. This, when injected into the diseased human body, supplements the antitoxin there found, and by so much the patient is aided in his struggle. With both these diseases the success of the serum treatment has been pronounced. A recent study of 200,000 cases in which the antitoxin of diphtheria was used shows the fatality from that disease to be reduced from 55 to 16 per cent. The problems presented by other infectious diseases seem to be more difficult. What seems to be required in most cases is a serum containing in quantity rather the cytolytic than the antitoxic substance, and as yet an efficient serum of this nature has not been found. Any day may yield such an one. But the matter of the relation of cytolysins and antitoxins, and their respective efficiencies in specific diseases, needs much elucidation. Serum therapy is in its infancy, but its methods appear so rational that it seems destined to develop into a most efficient branch of scientific medicine.

Second only in importance to the cure is the prevention of a future attack of the disease, or, in other words, the conferring of immunity on the individual. The disease itself, when running its natural course within an individual, confers a natural immunity against a subsequent attack, and with many diseases this may prove to be a life-long protection. Typhoid fever and smallpox, for example, rarely attack the individual a second time. In its present state the serum treatment also accomplishes immunity in some, though slight, degree, but greater and more lasting efficiency is desired. Probably no problem in bacteriology is being attacked more vigorously and more widely at the present time than this. A suggestive hypothesis by Ehrlich as to the chemical relations of the invading cells and the cells of the body has stimulated investigations in many laboratories, and both the nature of immunity and the best method of accomplishing it, which have puzzled medicine so long, bid fair to become known in the near future. With this achieved, preventive medicine will have gained one of its greatest triumphs.

A word should here be said regarding two of the infectious diseases whose peculiar method of transmission, long a mystery, has now become known. I refer to malaria and yellow fever. The able work of Laveran, Manson, Ross, Grassi, Koch, and others on the former, and that of Reed and other courageous Americans on the latter, have demonstrated conclusively that these diseases are transmitted from man to man through the aid of the mosquito, which, receiving the germ from an infected individual, cultivates it within its own body and later delivers it in a properly prepared form to another unfortunate human being. Moreover, it is entirely probable that this is the sole method of transmission of these diseases. The ounce of prevention here consists in: first, eliminating from the community, so far as possible, the breeding places of the mosquito; secondly, totally preventing, by simple screens, the access of the insect to each case of the disease. By the employment of these simple methods in Havana, during the year ending with the end of last September, not a single case of yellow fever originated within the city, an event unparalleled in recent times. The active work now being carried on by the Liverpool School of Tropical Medicine on the West coast of Africa bids fair to reduce materially the extent of malarial fever, so long the scourge of that region.

It is impossible to predict the full outcome, in the future, of the diligent research of the past few decades in the field of the infectious diseases. Certain it is, that in civilized countries there appear no more the terrible epidemics of the past, such as the Black Death, which, in the fourteenth century, ravaged much of the continent of Europe, and in England swept away more than half a population of three or four millions. The struggle of the deadly germs for existence is becoming daily a more desperate one. Just as paleontology has revealed numerous instances of the annihilation of once flourishing species of organisms high in the scale of life, it is perhaps not visionary to look forward to the ultimate extinction of these more lowly forms, and, with them, to the abolishment forever from the face of the earth of the diseases which they cause.

The study of the micro-organisms in the past and present bears upon a much wider range of subjects than the immediately practical one of the prevention and cure of individual diseases, however important that may be. It is constantly aiding, in ways surprising and unforeseen, in the solution of even long-standing and remote problems. I need only mention here that of the recognition of human blood as distinguished from that of lower animals. Moreover, this study has helped in the elucidation of many of the fundamental problems of protoplasmic activity, and has given men of medicine a broader culture and a higher outlook over the accomplishments and possibilities of the human organism. This cannot fail to react upon other fields than that of the infectious diseases, to make treatment in general a more rational matter than it has ever been, and to uplift the whole science of medicine.

Before finally leaving this subject, I would speak of the many instances of personal heroism exhibited by the men who have labored in this field. The records teem with stories of those who, recognizing more fully and intelligently than others the dangers that surrounded them, and the deadly risks they were incurring, have, nevertheless, led by their great courage and scientific devotion, gone steadily forward, sometimes to death itself. There is danger in the laboratory and the hospital, and greater danger in the midst of epidemics. "What does it matter?" replied Pasteur when his friends spoke of these perils. "Life in the midst of danger is *the* life, the real life, the life of sacrifice, of example, of fruitfulness," and he continued his labors. The death from cholera of a devoted and much-loved pupil of his at Alexandria, whither he had voluntarily gone to investigate the dread scourge of 1883, was a great grief to the master, but only intensified his devotion to his work. Since then many others have met an end as heroic, martyrs to the cause of medical progress. Among these I need only mention our own Lazear, who gave up his life in the yellow-fever laboratories in Cuba. Notwithstanding such tragedies, the laboratories and hospitals are always full of workers, and each new epidemic finds those who are eager to go to the scene to aid. The good to be performed, and the honors to be won overcome the fears, and the ranks of laborers in this most deadly province of scientific medicine are never wanting in men.

Internal Secretion.—Leaving the subject of the infectious diseases, let me turn now to a mode of treatment based on recent experimental work, and applied successfully to certain unusual and grave maladies, which are evidently accompanied by disordered nutrition, but the cause and proper treatment of which until very recently were obscure.

About a dozen years ago the phrase "internal secretion" began to be employed in physiological laboratories for the first time, and for a newly recognized function of glandular organs. It was well known that glands receive from the blood raw material, and manufacture from it specific secretions, which are discharged either outside the body for excretion, as is the case with the perspiration, or to the surface of mucous membranes for use in bodily function, as instanced by the gastric juice. It was discovered, however, that certain glands, such as the thyroid, the suprarenal, the pancreas and others, manufacture and return to the blood specific substances, differing with the different glands, but of important use to the body, and the absence of which leads to profound consequences. These substances were called *internal secretions*. Thus, removal or suspension of the function of the thyroid gland, and hence the loss of its internal secretion, reduces the body to a serious pathological state, long recognized by the name myxedema. Of similar causation is the peculiar condition, called cretinism, which is characterized by a physical and mental stunting of the growing individual. The rare Addison's disease is associated with disturbance of the function of the suprarenal glands; and other instances might be mentioned. It seemed a simple step from the discovery of the cause to the discovery of a cure. If absence of a substance is the cause of a disease, supplying that substance ought to effect a cure, and such was found to be the case. Administering to the afflicted individual the fresh thyroid gland of animals or a properly prepared extract of such gland, was found to alleviate or cure myxedema; and other instances of the efficiency of glandular products were recorded. So striking were the facts that active investigation of the matter was undertaken, with the result of showing that the chemical interrelationships of the various tissues of the body were profound, and a knowledge of them of exceeding value to the physician. As a possible instance of this may be mentioned the idea, recently suggested by Prof. Herter, of New York, that the suprarenal gland, by means of its internal secretion may control the manufacture of sugar by the cells of the pancreas, an idea which, if proved true, may bear significantly on the causation and treatment of diabetes. There is need of much research in this field of the internal secretions, but already glandular extracts have proved a valuable addition to the remedies of the scientific physician.

Brain Surgery.—I have already spoken of the entire change in the methods of general surgery during a period of twenty-five years, owing to the rise of bacteriology. But I ought to mention specifically the remarkable advance made during the same time in the surgical treatment of diseases of the central nervous system, the brain and spinal cord, for it is here that the scientific method has achieved one of its most complete triumphs.

Although it was pointed out by the French surgeon, Broca, as early as 1861, that the loss of the power of speech is associated with disease of a certain portion of the left hemisphere of the brain, it was still the general belief that the acting brain acts as a whole. This idea prevailed until 1870, when the German physiologists, Fritsch and Hitzig, demonstrated that stimulation of different areas of the cerebral surface evoke in the body different movements. This was the beginning of the experimental investigation of *cerebral localization*, a line of research which has proved rich in results. The brain is not one organ acting as a whole, but an association of many organs, each with its specific duty to perform, but intricately associated with all the others. In the years that have passed since the discovery of Fritsch and Hitzig it has been the task of neurologists to discover the functions of the different parts of the central nervous system, to unravel their intricate interconnections, and to associate the disturbance of their functions with external symptoms in the individual. As a result of this labor the neurologist, after a careful study of his patient, now says to the surgeon, "Cut there, and you will find the disturbing agent"—and the brilliant success of the brain surgery of the present day justifies its scientific basis.

The New Physical Chemistry.—In the early part of this address I spoke of the freedom with which medicine made use of discoveries in other sciences than its own. A very recent striking illustration of this is that of the application of the principles of the new physical chemistry to the phenomena of the living body. From the standpoint of physical chemistry the body may be regarded as a mass of minute particles of semi-liquid living substance, the protoplasmic cells, each surrounded by a thin permeable membrane, the cell-wall, and bathed externally by the circulating liquids, the blood and lymph. Both the protoplasm and the external liquid contain substances in solution, and whatever passes between them, be it food, or waste, or drug, must pass in the form of a solution through the intervening cell-wall. The laws of solutions and the laws of the passage of solutions through membranes must hence find their applications in the body. It has been the general belief that when a substance becomes dissolved its molecules remain intact, and are merely separated from one another by the water or other solvent. Quite recently physical chemistry has shown that this view is not altogether correct, but that a varying amount of disintegration takes place, a dissociation of the molecules into their constituent atoms or groups of atoms. Moreover, these dissociated particles, *ions*, as they have been called, are charged with electricity; some, the *kations*, charged positively; others, the *anions*, negatively. Electrolytic dissociation is much more pronounced in solutions of inorganic than of organic substances. In proportion to its extent, specific properties are conferred on these solutions. What these properties are is not altogether clear, but it is entirely probable that the specific properties of many drugs are dependent, in part at least, on the amount of their dissociation when in solution. Furthermore, the amount of a given substance which is able to pass through a membrane is measured by the so-called *osmotic pressure* of the substance, and this, which varies with the concentration of the solution, seems to depend on the movements of the molecules and the ions within the liquid solvent. Since the physician, in the giving of a drug, wishes to induce certain cells of the body of his patient to absorb certain quantities of the drug, it is obvious that a knowledge of the principles by which substances pass through membranes will aid him.

The laws of solutions and the laws of osmosis still remain largely obscure, and because of this literature of the subject contains much that is of little value—deductions from insufficient data, conclusions of one day which are overthrown by the researches of the next, fantastic imaginings which only throw discredit on the really worthy, and hopes buoyed up by the light of an *ignis fatuus*. But enough of truth has been already revealed to stimulate active research for the sake of physiological progress, and to show that the subject bears profoundly on the problems which the physician meets daily. It is partly along this line that the revitalized science of pharmacology, the study of the physiological action of drugs, which for several years has been actively pressing to the front, promises to make still more rapid progress in the near future.

Medical Schools.—The growth of scientific medicine, some of the branches of which I have thus tried to

present to you, has reacted powerfully on our medical schools. The prominent features of this reaction are: the increase in the requirements for admission, the greater amount of laboratory and clinical instruction, the extension of the course in length, and the inclusion of the medical schools within universities.

Within a few years the requirements for admission to medical study have been raised from an elementary education, by many schools to that of a high-school course or college preparation, by a few to a partial college training, and by two to a full college course with a resulting bachelor's degree. As the wisdom of the latter is still not generally conceded, it is doubtful whether in the near future it will become widespread. Ideal as it seems, the one argument against it, that thereby the young man is forced to delay entrance to his life-work until a late age, has never been satisfactorily answered. President Butler's recent pronouncement in favor of a division of the college work into a two-year and a four-year course has much in its favor. This would allow a certain amount of those studies which are pursued for the purpose of general education and culture, and a grounding in the especially necessary chemistry, physics and biology.

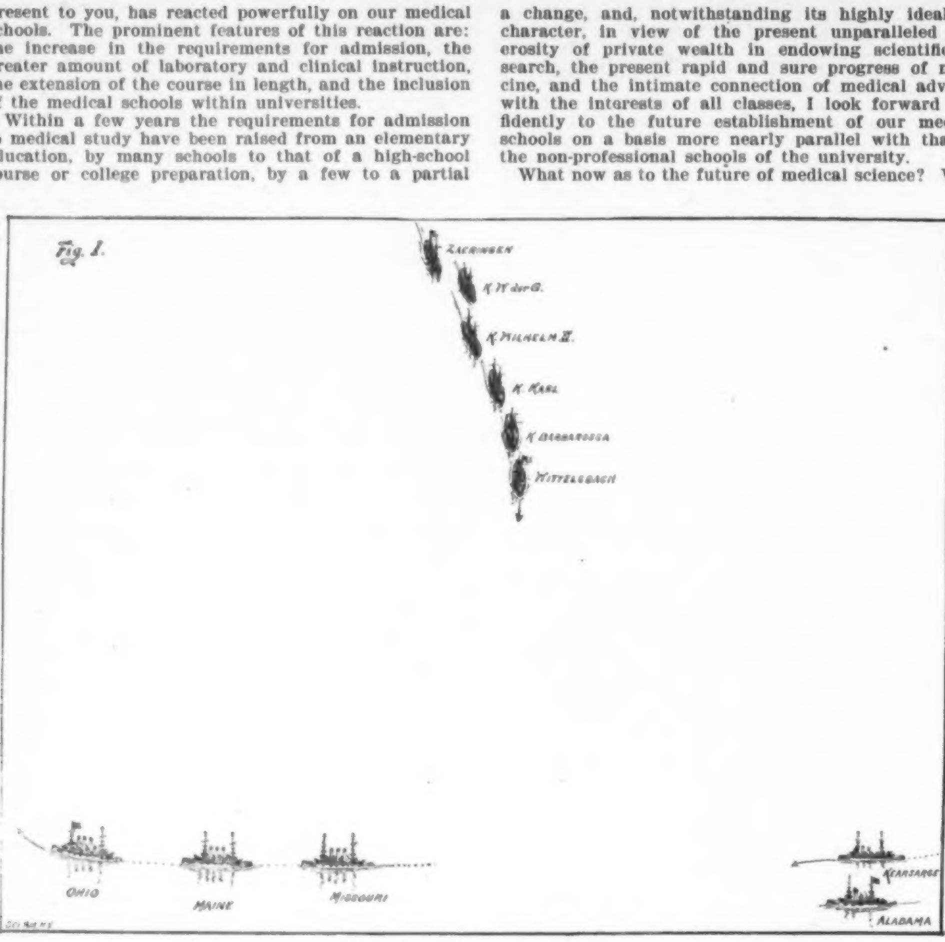
The increase in the amount of laboratory and clinical instruction is merely in harmony with the truth that seeing is believing. "Study nature, not books," says Agassiz, and he might have added for the guidance of the teacher, "Weary not your pupils with words, let them see things."

In length the medical course has rapidly increased from two to three and from three to four years. With the increase in the number of hospitals throughout the land, and the opportunities offered therein to recent graduates to serve an internes under competent visiting physicians, one or two years more may be added to the student's equipment, making a training of five or six years before the young doctor actually begins independent practice.

The inclusion of the medical schools within universities is one of the most important advances of medical education made in many years. Of the 156 schools existing in this country, 74, or nearly one-half, are departments of colleges or universities. In this respect, however, America is still far behind Germany, for in the latter country no medical school exists except as a part of the larger institution. The advantages of such a connection are too obvious to dwell upon. Apart from the material benefits that are likely to accrue to the school, and the prestige granted it in the educational world, there is the atmosphere of a higher culture, a more scientific spirit, and less utilitarianism, which is breathed by instructors and students alike, and which cannot fail to make the graduates broader men. In the larger of these university schools a portion of the teaching body consists of men who do not engage in medical practice, but like the instructors in the non-professional schools of the university, give their whole time to their specialties, in teaching and research. Usually these are the holders of the chairs of the non-clinical, basal sciences, anatomy, physiology, pathology, bacteriology, physiological chemistry and pharmacology. The outcome of this must be to broaden and deepen the scientific basis of medicine. The clinical branches are still taught by men who are at the same time private practitioners. In a recent thoughtful essay on "Medicine and the Universities," a professor in one of our leading medical schools urges the further severance of medical teaching and private medical practice. He would have internal medicine, surgery, obstetrics, and, indeed, all the principal clinical departments of instruction, placed, like the fundamental sciences, "on a true university basis," by which he means that the holders of these chairs should devote all their time and energy to teaching and research. This would require the paying of large salaries and the building of extensive university hospitals, wherein the professors could carry on their investigations. In my opinion the benefits that would thus accrue to scientific medicine far outweigh the arguments that may be brought against so radical a change, and, notwithstanding its highly idealistic character, in view of the present unparalleled generosity of private wealth in endowing scientific research, the present rapid and sure progress of medicine, and the intimate connection of medical advance with the interests of all classes, I look forward confidently to the future establishment of our medical schools on a basis more nearly parallel with that of the non-professional schools of the university.

What now as to the future of medical science? With the impetus which it has received from the mighty strides of the past twenty-five years, its future progress and future great achievements are assured. But it behooves us, in whose hands lies the training of the physician, to see that he enter on his work with a full realization of his responsibilities. *The future of scientific medicine lies with the university.* "Though the university may dispense with professional schools," said President Wilson in his inaugural address at Princeton a few weeks ago, "professional schools may not dispense with the university. Professional schools have nowhere their right atmosphere and association, except where they are parts of a university and share its spirit and method. They must love learning as well as professional success, in order to have their perfect usefulness." The perfect usefulness of the professional school consists, not merely in teaching our embryo physician how to destroy bacteria, to remove tumors, or to calm the fire of fevers. These things he must understand, and these he must do daily for the suffering individual. But beyond these are larger tasks. The physician's should be a life of service and of leadership combined. He serves well when he relieves suffering; still better when he teaches men how to live; but he serves best of all when he pushes out into the unknown and makes medical science the richer for what he contributes to it. The knowledge of wise men, the deeds of diligent men and the valor of heroes are the gift of those who have preceded him. Let us see to it that he pass on this heritage, augmented, to those who follow.

Columbia University.



THE GERMAN ADVANCE.

THE NAVAL WAR GAME BETWEEN THE UNITED STATES AND GERMANY.—XI.*

By Fred T. Jane.

GREAT AMERICAN VICTORY IN THE FAR EAST.

Following upon the partial action recorded last week, the American fleet prepared for the expected night action that the Germans were bent on forcing.

At sundown the German fleet was visible on the horizon—the main body a long way off, with two ships, taken for the "Wittelsbach" and "Zaehringen," somewhat nearer, acting as the scouts of a fleet devoid of cruisers.

The U. S. S. "Maine," "Ohio," and "Missouri," pressed toward these at full speed, the rest of the American fleet following astern as well as it was able.

The two German vessels, in no way anxious to try conclusions with the three "Maines," fell back toward their main body. This move being well in progress, the two slow American ships "Kearsarge" and "Alabama" turned about, making for a rendezvous. This they succeeded in doing without observation.

The three "Maines" meanwhile continued to press as much as was safe, and by nightfall were little more than ten thousand yards from the Germans, who presently stopped, and then started to close on the Americans.

Then the "Maines" beat a retreat, drawing the Germans away from their two slow consorts.

The move was an exceedingly daring one; however, the American admiral was so nervous as to the almost inevitable result of a torpedo contest that the circumstances may be said to justify it more or less.

In any case results did. The "Maines," keeping a straight course at full speed were easily kept in sight by their antagonists, who gradually began to tail out, only the two "Wittelsbachs" being allowed a steaming power equal to that of the "Maines."

About midnight the "Maines" began to curve toward the rendezvous, and by two o'clock some of the German vessels were able to act on interior lines sufficiently to press.

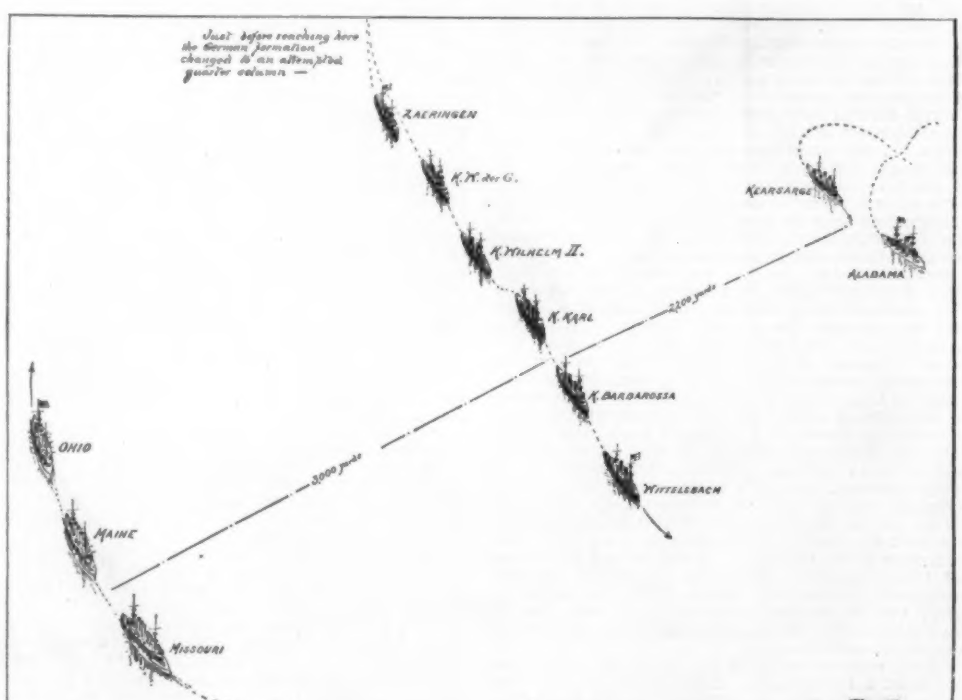
This continued till about three, about which time one of the German players, the "Zaehringen's," made an error in moving which, by the rules, constituted an engine-room breakdown. On this the Germans abruptly ceased the chase, altering course sixteen points together.

This they did very suddenly, and by a subsequent alteration were able to get entirely out of touch of the Americans, who vainly tried to pick them up again. The "Maines" therefore proceeded to the rendezvous, and picking up the slow ships, returned to their old cruising ground off Kiao Chau.

The German admiral claims to have decided to withdraw before the "Zaehringen" broke down, an idea of a trap having occurred to him.

ATLANTIC MOVES.

In the Atlantic nothing further has happened. Armed liners have chased each other without result, but the main German fleet still lies at Havana, while the Americans as persistently stick to Key West.



CUTTING THE LINE.

The real reason of the German inactivity is that the umpires have reduced the speeds of several ships on account of Atlantic voyage, and put several destroyers temporarily *hors de combat*. The Germans are compelled to wait till these defects are "repaired," but the

* Prepared especially for the Scientific American by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the Scientific American Supplement of December 20, 1902.

reason not being known to the Americans, wild surmises can alone obtain.

As for the American admiral, he is by no means anxious for an early fight, being glad of any opportunity for farther thought about how his fleet of monitors and armed liners can best go into action.

PRACTICAL ANNIHILATION OF THE GERMAN FLEET.

On the morning following the night operations above referred to, the American and German fleets sighted each other off Kiao Chau.

The American fleet was in line ahead, the order being (first division) "Ohio," "Maine," "Missouri," (slow division) "Alabama," "Kearsarge." The Germans, when first sighted some 12,000 yards away in the dawn were in line abreast, the "Wittelsbach" and "Zaehringen" at the wings, the rest of the ships, four "Kaiser" class, in the center. On sighting the Americans they altered course together into line ahead, steaming very fast so as to get round and ahead of the American line.

In part with a view to prevent this, in part with a view to the carrying out of the tactics that he had in view, the American admiral put on full speed in the "Ohio," "Maine," and "Missouri." The result of this was that a gap was left between these ships and the "Alabama." This gap grew greater still when the "Alabama" was seen to haul out of line and gradually drop astern of the "Kearsarge." (Fig. 1.) This particular move it was that decided the issue of the battle. Had the "Alabama" kept her place, it is likely enough that the German admiral would have suspected something; seeing the "Alabama" dropping, he fell into the trap prepared for him, and took it for granted that the Americans were making a full speed rush for the head of his line.

Round at once came the German fleet. There was a chance to "cut the line," and the temptation to use this classical attack was irresistible. Fire was opened, therefore, with the German line impinging at right angles on to the American one, and the cutting off of the two slow Americans looked a certainty. (Fig. 1.) On the other hand, every American vessel was able to bear in detail on the approaching vessels.

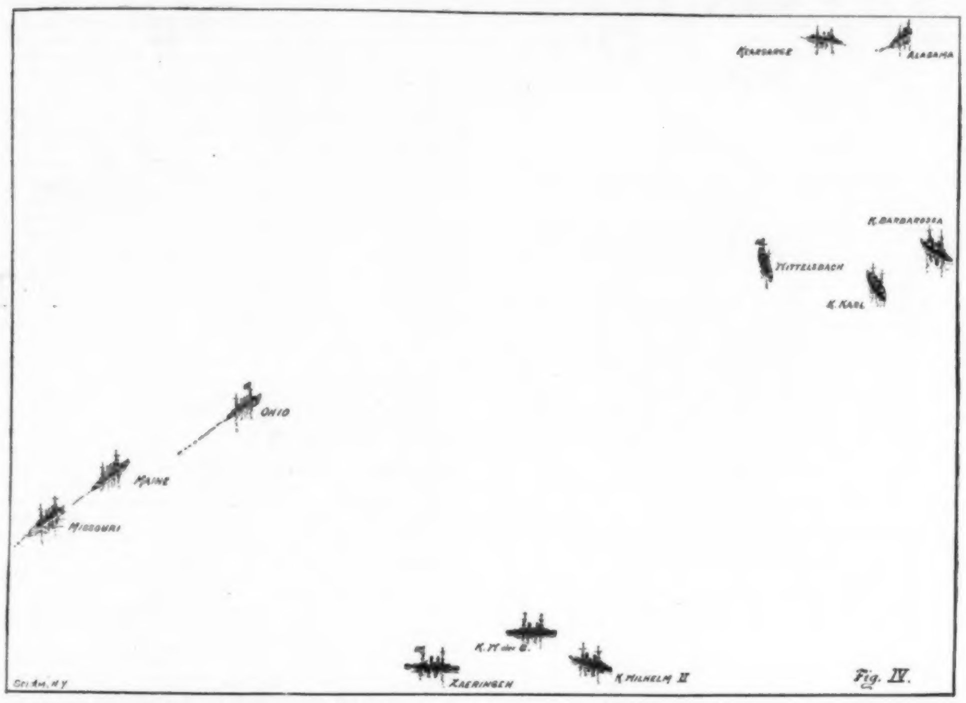
The situation, from the American standpoint, was now a delicate one. There was a risk of the German admiral realizing his error, there was also a risk that he would go astern of the "Alabama," in which case the destruction of the two lame ducks was certain.

With a view to preventing this, some considerable *finesse* was necessary, and it was certainly displayed. The three "Maine" class began to swing round, and a great show was made of an attempt to join up the threatened line. Still more cunning, however, was the American fire system. By this only the "Kearsarge" fired at the German flagship, all the other ships pounding the "Kaiser Barbarossa" and "Kaiser Karl der Grosse," the second and third ships in the German line. By this means the German admiral, little hurt himself, did not immediately realize the situation into which he had tumbled.

He had, indeed, cut the line before he realized it. Then (Fig. 2) realization was too late. Turning to port, the "Kearsarge" and "Alabama" engaged the first three Germans; bearing to starboard on the other side, and going in the opposite direction, the "Ohio," "Maine," and "Missouri," engaged the "Kaiser Wilhelm II," the "Kaiser Wilhelm der Grosse," and the "Zaehringen."

The range was kept at 3,000 yards, out of the torpedo zone. The American gun fire was the more powerful, and presently rounding the stern of the "Zaehringen," the three concentrated on and demolished that ship. The leader of the second line, the "Kaiser Wilhelm II," was unable to steer, and here matters resolved themselves into a pounding match, the odds ever growing against the Germans. At last their fire ceased, and the "Zaehringen" hoisted a white flag. What was left of this division had surrendered.

(To be continued.)



POSITIONS WHEN FIRST DIVISION WAS ABOUT TO COMPEL GERMAN TAIL TO STRIKE.

CONTEMPORARY ELECTRICAL SCIENCE.*

PRESSURE OF RADIATION.—Since the days of Kepler, the apparent repulsion of comets' tails by the sun has presented a notable exception to the law of gravitational attraction. Kepler's explanation was based upon a supposed pressure of light, and this is now known to be nearer the truth than Newton's explanation based upon the presence of a denser interstellar medium, or Olbers' electric-repulsion theory. The existence of the Maxwell-Bartoli pressure of radiation has been experimentally proved by Nichols and Hull and by P. Lebedew. The latter represents the pressure acting upon a body exposed to sunlight as a fraction of the gravitational attraction equal to

$$1 - \frac{1}{10{,}000rd}$$

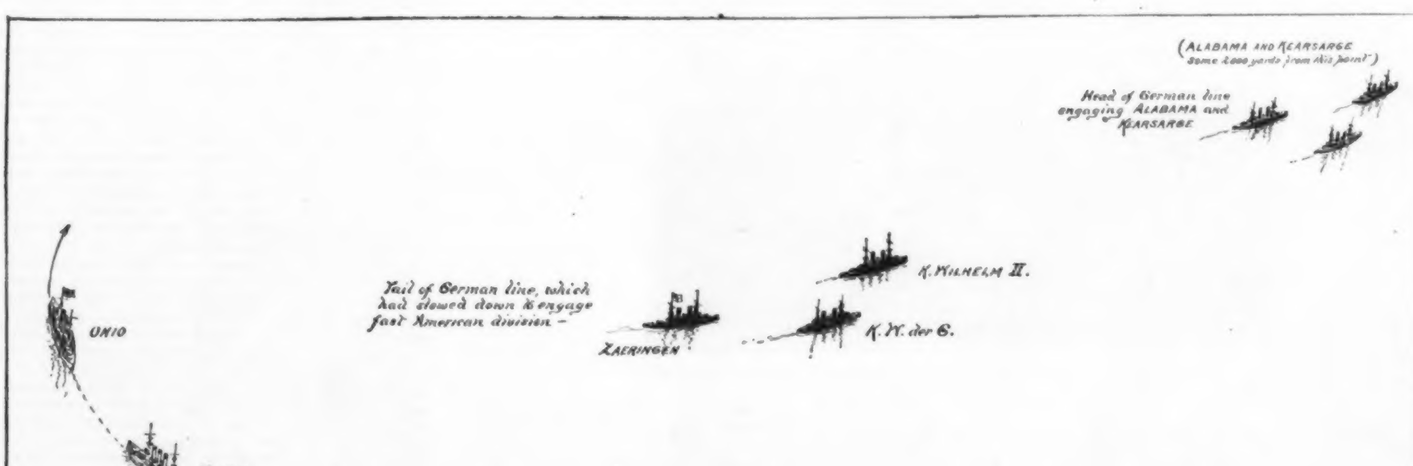
where r is the radius of the body in centimeters and d its density with respect to water. The larger and denser the body is, the less will it be affected by the pressure of light. If its diameter is 1 meter and its density that of water, the attraction will be diminished by one-millionth, and our instruments will be unable to discover any effect. When the diameter is about 0.001 mm., or of the order of the light waves, the attraction will be just balanced by the repulsion. The actual repulsion observed in comets will give us a means of measuring the diameter of the meteorites of which they consist. The above formula cannot be directly applied to molecules, since certain resonance phenomena intervene in this case.—P. Lebedew, Physikal. Zeitschr., October 1, 1902.

ELECTRON THEORY.—H. A. Lorentz has made an important theoretical advance in the electron theory. In a paper on "The Fundamental Equations for Electromagnetic Phenomena in Ponderable Bodies, Deduced from the Theory of Electrons," the author passes from the case of the propagation of light in transparent substances moving with a constant velocity to a more general case. He transforms the original equations into a set of formulæ which, instead of quantities having reference to individual electrons, contain only such as relate to the state of visible parts of the body, and are, therefore, accessible to observation. These formulæ hold for bodies of very different kinds, moving in any way we like. The results are mainly those arrived at by Poincaré, although the treatment is different. The ether is, as before, supposed to remain at rest and to penetrate the charged particles. The equations of the electromagnetic field are, therefore, to be applied to the interior of the electrons, as well as to the spaces between them. The two final equations deduced are the well-known ones curl $E = -B$ and div. $B = 0$. They may be used without applying them to individual electrons, but they are intimately connected with the distribution and motion of elementary electric charges.—H. A. Lorentz, Proc. Roy. Akad., Amsterdam, September 27, 1902.

LUMINOUS ELECTRIC WIND.—In a point discharge in air and other gases at atmospheric pressure the luminous effect at the negative point is limited to a bright star, which represents the negative glow-light seen in vacuum tubes. E. Warburg has observed, however, that in nitrogen, freed from oxygen by glowing copper, a fine brush of light may be seen to proceed from the star when a strong current is used, such as is furnished by a high-tension accumulator. On introducing the point into the axis of a platinum cylinder, it is possible to follow the brush for about 8 cm. down from the point. The brush penetrates wire gauze, and when it impinges upon the wall of a vessel, it passes along it as a whitish cloud. On breaking the current, the gas shows the phenomenon of residual glow. What happens is that a slight chemical change is produced in the gas constituting the electric wind, and this change is reversed on breaking the current. The electric wind is, however, only a small constituent of the total current from the point. When oxygen is present in any quantity, there is no glow, nor is there any when the oxygen is entirely removed with sodium. There is, therefore, a maximum effect, as in fluorescent solid solutions.—E. Warburg, Physikal. Zeitschr., October 10, 1902.

CONSTRUCTION OF TESLA TRANSFORMERS.—The main problem of Tesla transformers is that of establishing magnetic resonance between a coil of a few turns attached to a capacity with a coil of many turns without terminal capacity. This involves a lengthy process of trial and error, especially in the construction of powerful transformers. P. Drude, therefore, works out a method of calculating the period of the secondary coil and the inductance of the primary. Incidentally, some points of importance for radio-telegraphy are touched upon. The period of oscillation of various coils of wire was determined by exciting them by

* Compiled by E. E. Fournier d'Albe in the Electrician.



THE AMERICAN FAST DIVISION ROUNDING THE TAIL OF THE GERMAN LINE.

means of an exciter of known dimensions, and noting their maximum resonance. Results obtained on one coil can be transferred to another and geometrically similar coil by simply multiplying them by the ratio of any homologous linear piece. To obtain maximum efficiency, wood should not be used for cores of coils. Ebonite or glass is preferable. Cotton insulation of the wires increases the period by about 1.5 per cent, if its thickness is equal to that of the wire. Half the proper wave-length of a nearly closed circle of thin wire is 6.5 higher than the length of the circumference. The period of a coil is always increased by a terminal capacity, but is never doubled.—P. Drude, Ann. der Physik., No. 10, 1902.

HIGH TEMPERATURE ELECTRO-CHEMISTRY: NOTES ON EXPERIMENTAL AND TECHNICAL ELECTRIC FURNACES.*

By R. S. HUTTON, M.Sc., Associate, and J. E. PETAVEL, Associate Member.

ALTHOUGH a few pioneers like Siemens and Cowles foresaw the importance of the application of the electric furnace to chemical problems, it is only within the last ten years that most of the important processes have been developed. With the discovery of calcium carbide in 1892, the commercial possibilities of making use of the extreme temperature produced in the electric arc seem to have first forcibly impressed themselves both on the chemist and engineer, and the demands for power thus created brought into existence all over the world large generating plants, of which Niagara is a typical instance. In the early days Cowles found great difficulty in obtaining an electric plant of sufficient power for his purposes,† but soon the electrical engineer, realizing the nature of the demands made upon him, was fully able to cope with them. The provision of cheap power has in turn reacted in stimulating the development of many new chemical industries. The magnitude of the present development of electric power for chemical purposes is clearly brought out in the statistics published by Swan.‡ It is usual to explain the very small progress of electro-chemistry here as compared with other countries by invoking the well-worn excuse that comparatively little water power is available in Great Britain. This subject is worthy of much closer attention than has been given it in the past. In the first place it is well to remember that in a great number of cases the cost of power is only a small percentage of the prime cost of the manufactured material. Again, the water power is frequently most inaccessibly situated, thus raising very considerably the cost in freight on raw material and finished product.* Owing to the improved efficiency of the steam engine, and to the huge progress made recently in the application of the gas engine to large powers, the cost of energy derived from coal is daily becoming less,† and is already capable of competing successfully with the less favorably situated water powers.

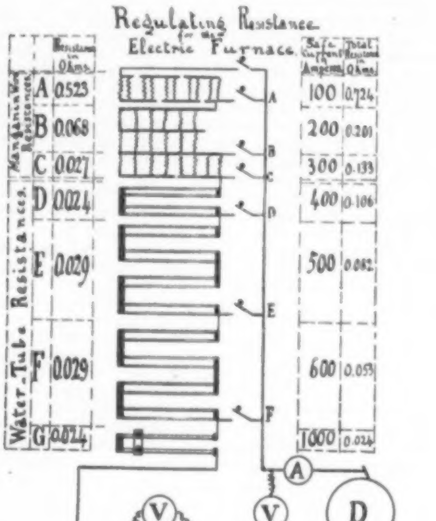


FIG. 1.—DIAGRAM OF REGULATING RESISTANCE FOR ELECTRIC FURNACE.

Frames A, B, C, are manganin wire resistances, and together with the corresponding switches are mounted on a stand fitted with rollers. The other frames consist of German-silver tubes fixed permanently to the wall and provided with a water circulation. D is made of ¼-inch tubes about 4 feet long, and 0.025 inch thick, E and F of ⅜-inch tubes 3 feet long and 0.03 inch thick, while G is of ½-inch tubes 6½ feet long and 0.02 inch thick.

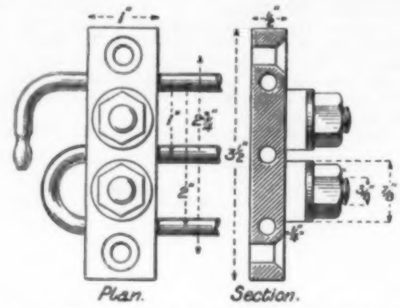


FIG. 3.—TERMINALS OF WATER TUBE RESISTANCE. (600 AMPERE FRAME.)

The German-silver tubes are soldered into gun-metal strip carrying two ¾-inch bolts. The water passes in series through several tubes, connections being made by means of a U tube as shown in the figure. The gun-metal strips are mounted on wooden frames.

There is, indeed, no valid reason why many of the electro-chemical industries should not be a success in this country. As will be seen later, a considerable number of electric furnace products are absorbed directly by the iron and steel industries, which of all manufactures in this country are probably the most favorably situated for obtaining cheap power. The manufacture of the alloys of the rarer metals, either in direct connection with some existing steel works, or at any rate in these districts, should offer every economical advantage; moreover, in these cases the raw product forms a very large proportion of the total cost. Much has been written of the future which has been opened up by the application of producer and blast furnace gases,‡ but even if we were to consecrate our whole time to the importance of this subject in its bearings on the electro-chemical industry, we could hardly do it justice. We will therefore pass directly, first to the consideration of the subject in its experimental stage, and then follow it in some of its commercial applications.

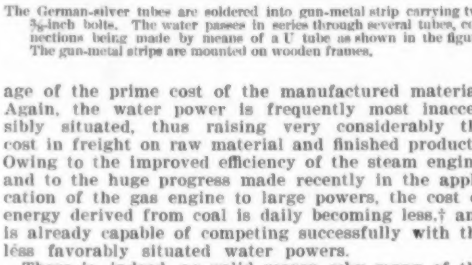


FIG. 4.—TERMINALS OF WATER TUBE RESISTANCE. (1,000 AMPERE FRAME.)

Gun-metal castings form the mounting for the German-silver tube, and carry two ¾-inch bolts by which the connections are made.

PART I.—EXPERIMENTAL EQUIPMENT.

In considering the equipment of a laboratory for experimental work in electro-metallurgy, the point of utmost importance should be, in the first place, to provide power to enable the experiments to be carried out on a reasonably large scale. The actual magnitude of the power equipment must be regulated by two principles. It is very desirable that the experiments, though not on a scale directly comparable with the commercial process should, nevertheless, be of sufficient magnitude to furnish reliable practical data. On the other hand, as the question of cost has unfortunately to be considered, it is necessary to keep the equipment within certain limits, so that any given experiment can be repeated frequently under all possible conditions. Such work will supply not only valuable scientific information, but also the necessary data for practical application. Having said this much with regard to the scale of the work, let us consider what should be the main points governing the choice of equipment. As we shall see later, the variety of different forms of electric furnaces which have been proposed or used is extremely great, and it would be altogether impossible to provide in any laboratory, however large or wealthy, even the most important of these. With regard to the generating plant the same may be said. In commercial work we find conditions varying from the 15,000-volt nitric acid plant down to the 4 or 5 volts required by the zinc or aluminium processes; from the continuous current used in all electrolytic work, to the mono- or multi-phase alternating current employed in the purely electro-thermal reactions. Our object therefore must be, not to establish a limited number of definite examples, but to obtain an equipment extremely flexible so that without serious expense any of the conditions required by such work may be obtained. It is unfortunately rarely possible to turn an ideal into a concrete fact; the development of a laboratory must necessarily be gradual, each year bringing alterations and improvements. Nevertheless a description of the actual equipment of the electro-chemical laboratory of Owens College may be of some value to those interested in the subject either from a commercial or theoretical point of view. The motive power at present available is rather insufficient, but hopes are entertained that it may before long be increased. It consists of a gas engine and motor which can be coupled on to the same driving shaft, and together are capable of developing a net output of 30 to 40 kilowatts. The generating plant comprises several different types of machines.

One unit of 40 kilowatts is capable of being connected so as to give any electromotive force between 10 and 200 volts, the maximum current being 600 amperes. This dynamo is used for arc furnace work. Further, a dynamo specially intended for electrolytic work, capable of giving 1,000 amperes at 15 volts. With regard to alternating currents, a 40-kilowatt three-phase and a 20-kilowatt single-phase machine are provided. The latter can be connected so as to give anything between 30 amperes at 600 volts and 250 amperes at 75 volts. Finally, plant used some time ago by Mr. McDougall for the manufacture of nitric acid was presented by him to the laboratory. It will give alternating current up to 16,000 volts. Passing now from the dynamo house to the electro-chemical laboratory itself, the first problem is the exact regulation of these comparatively large currents, since for satisfactorily studying some of the electrolytic processes it is absolutely essential to have the current entirely under control. The diagram of the series resistance used for this purpose is shown in Fig. 1; as will be seen a number of switches are provided, by means of which successive portions may be short-circuited.

This resistance is divided into two parts, the first of manganin wire designed particularly for starting an arc furnace, and capable of being used for currents up to 300 amperes; the second consisting of German silver tubes, water-cooled, and with maximum carrying capacity of 1,000 amperes. After some consideration the water-tube resistance was chosen as being the most suitable for regulating large currents,* and as this subject is of some general interest we venture to give details of the design and of the behavior under actual working conditions. The design of the water-tube frames is shown in Fig. 2, which gives a general view of the frames, and Figs. 3 and 4 giving detail of the design of the terminal pieces. The frames are of two types, the first being made of parallel ¼-inch tubes for currents of 600 amperes and below. As will be seen, these tubes are let into ½-inch by 1-inch gun-metal strips, which are fixed on to wooden frames; each strip carries two ¾-inch set screws serving as terminals. One of these is used for the permanent leads, the other is useful to fix any temporary connection. The second type of frame for 1,000 amperes consists of two ½-inch German silver tubes, 6½ feet long, connected in series, and has a resistance of 0.024 ohm. The terminals shown in Fig. 4 are similar to those just described, but more massive. Two sliders are provided of the design shown in Fig. 5, by which the actual resistance in circuit can be varied, and the current adjusted with accuracy to the value desired.

As will be seen, there is a stiff central spring, by means of which the sliders are kept in contact with the tubes during adjustment. They can be clamped in any given position by two thumb-screws. In considering the maximum power which may be dissipated in a water-tube resistance we are concerned with two principal factors. First, the maximum rate at which water can be passed through the tubes; secondly, the maximum rate at which heat can be transmitted from the metal to the water. In all practical cases the first limiting factor will intervene long before the second would show its influence. The design of the water-tube frame will therefore depend on the dimensions of the tube and the available head of water. As a general guiding factor we may say that a flow of one liter per minute will dissipate up to 2½ kilowatts.†

Close to the water-tubes a resistance is provided by

FIG. 2.—REGULATING RESISTANCE FITTED FOR 40-KILOWATT MOISSAN FURNACE.

To the right is the portable resistance, and above the 500, 600, and 1,000 ampere short-circuiting switches. Bare copper strips 1¼ by ¼ and 2 by ¼ inches connect these switches with the different frames seen in the center. The two carbons are carried in massive copper holders which can be adjusted to any given height, the leads being bolted to the vertical standard of the holder of 2¼ square inches cross section.

* A paper read at meeting of Institution of Electrical Engineers, November 25, 1902, and revised by Prof. Hutton for the SCIENTIFIC AMERICAN SUPPLEMENT.

† Crompton, British Assoc. Reports, p. 809 (1888).

‡ Journal Soc. Chem. Industry, vol. 20, pp. 662-676 (1901). See also Borchers, Die Electrochemie auf der Weltausstellung in Paris, 1900. Halle p. 8.

* Report of Arrhenius to Swedish Government, see Electrician, vol. 47, p. 71 (1901).

† Humphrey, Proc. Inst. Mech. Engineers, 1901, pts. i. and ii., p. 41; Brit. Assoc., Sect. G., Belfast (1902).

‡ Bryan Donkin, Min. and Proc. Instit. Civil Engineers, vol. 148, pp. 1-55 (1902).

* See also Zeitschr. für Elektrochemie, vol. 8, pp. 6, 58, 123, 124 (1902).

† The larger tubes are the distinctly more satisfactory, since in this case there is no difficulty in obtaining an efficient flow of water from the ordinary supply. With the smaller tubes it is necessary to have numerous inlets and outlets, as their resistance to the flow of water is considerable.

which the exciting current of any of the dynamos can be most effectively regulated; it is in constant use for the considerable variations of voltage necessary during the progress of some of the furnace operations. We now come to the actual furnace equipment and the different types of apparatus which are best adapted for laboratory work. Foremost among these must be placed the Moissan furnace.* A dimensioned drawing of this type for a power of about 40 kilowatts is given in Fig. 6. Taking into consideration the many discoveries made by Moissan in the course of his investigations, it is surprising that as yet only a very small percentage have found commercial application. The reason of this may, perhaps, be ascribed to the fact that this form of furnace, though proving itself eminently suitable for the pioneering work for which it was intended, scarcely gives any data on which a technical process could be founded. It is, in fact, a striking example of how the apparatus most suited for purely scientific work is seldom capable of direct commercial application. It was not until the work was taken up by the practical engineer that the scientific discovery developed into a commercial industry. We shall see below that most frequently the financial success of a process has been in direct proportion to the mechanical improvements introduced, the chemical modifications being generally of secondary importance. It is therefore necessary to be able to provide a type of furnace corresponding in principle to the most usual technical forms, and thus carry out the experiments, if not on the same scale, at least in the same manner as would be done in the factory. Fig. 7 is a plan of an apparatus similar to that used by Haber,† which we have found extremely useful for representing many different forms of furnace. Connected as shown in Fig. 9A, it has proved itself most satisfactory for the manufacture of aluminium by the electrolysis of cryolite containing Al_2O_3; replacing the carbon block C shown in this figure by a small furnace built of loose bricks, a good example of a carbide "pot" furnace giving a most satisfactory yield of calcium carbide can be obtained. Frequently in the electrolysis of fused salts it is an absolute necessity to make the crucible lining of the material itself. This result is obtained (as shown by Muthmann, Hofer, and Weiss),‡ by the use of a water-cooled crucible. The arrangement is shown in Fig. 9B. While the vertical holder enables us to represent a large number of different types of furnace those of the Acheson Carborundum type can be very simply built up by the use of ordinary materials. Fig. 10 shows a carborundum furnace as used with 40 horse power.

The next figure (Fig. 11) is a drawing of a furnace suitable for making calcium carbide or for other furnace operations. The design is inexpensive, and the apparatus most serviceable.

Such experimental equipment will be of importance not only from an educational point of view, but it is by no means impossible that certain of the difficulties in technical processes may be overcome by its use. It is important, however, not to neglect the purely scientific work, which, though it may possibly not find any direct application in the immediate future, has, however, frequently proved to be the starting-point of notable advances. In this direction the work in progress consists in the determination of the effect of gaseous pressures on high temperature chemical phenomena; it is proposed to study carefully some of the gaseous and other reactions which may be expected to differ considerably from those occurring under ordinary conditions. The apparatus shown in Fig. 12 is destined for work up to 200 atmospheres, and for currents up to 1,000 amperes, and has been provided out of funds received from the Government Grant Committee of the Royal Society.

(To be continued.)

VENOMOUS SERPENTS.—V.§

By RANDOLPH I. GEARE.

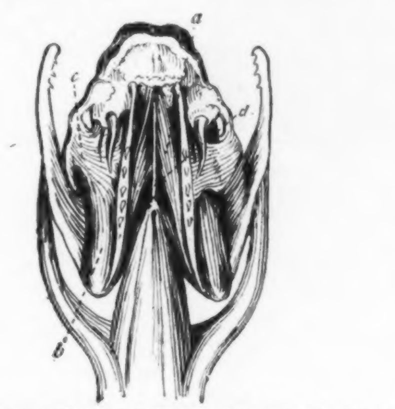
SNAKE VENOM.

A VENOMOUS snake is one which is provided with a specific poison and an apparatus especially adapted for introducing this poison into a wound. The mere fact that a snake-bite produces symptoms similar to those of poisoning is not sufficient to characterize the snake as "venomous." In general, the poisonous snakes of this or any country may be described as being possessed of a movable or constantly erect poison-fang at the anterior end of the upper jaw bones.

The real character of the venom has been a subject of some study and much speculation. In early days when organic chemistry was hardly developed as a science, there was much guess-work in this matter, which resulted principally in the concoction of numerous antidotes, most of which were then supposed to be infallible. To Prince Lucien Bonaparte belongs the honor of having made, in 1843, the first chemical analysis of viper poison, with the result that he declared it to be albuminoid or proteid in its nature, somewhat like the white of an egg. Early in the "sixties" Dr. S. Weir Mitchell, of Philadelphia, analyzed the poison of the rattlesnake, and corroborated the conclusions of Bonaparte as to the albuminoid nature of snake venom. Later, in 1881, Dr. Armand Gautier asserted positively that he had extracted from the venom of a cobra a small quantity of matter belonging to the organic alkalies, although he did not regard this as constituting the most dangerous part of the venom, which, he stated, was of a nitrogenous nature. The alkalies seemed chiefly to stupefy, but were not found to be necessarily fatal. The toxic constituent of the venom has been now proven beyond all doubt to be an albuminoid, as declared by Bonaparte. Later, in 1883, Dr. Mitchell announced that this albuminoid body (which in the venom of the rattlesnake he named "crotaline," and in that of the viper Bonaparte had named "echidine" or "viperine") is complex. An important point in this discovery is that the venom of both the rattlesnake and the cobra consists of several proteids, two of which preponderate, although present in each in a varying degree. These, according to Mitchell, are "globulin" and a peptone; although Wolfenden, an English physiologist, asserted that a peptone could not be present, referring this constituent to the albumoses, and in his analysis of the viper poison naming it *albumose* or *syntonin*, which is practically the same as Mitchell's peptone.

Another important point is that these two constituents are present in different proportions in the various poisons, the globulin occurring mostly in the Crotalids, but only in a very small degree in the cobra. And, as Dr. Stejneger points out in his "Poisonous Snakes of North America," this difference in the composition of the venoms corresponds to a marked degree with the difference in the symptoms accompanying poisoning by the Crotalids and the Vipers on the one hand, and by the Cobras and Elapids on the other hand.

Still later studies of the chemical nature of venom were made, as already mentioned, by Dr. C. J. Martin and Mr. J. McGarvie Smith, of Sydney, Australia. In this case the poison investigated was that of the Australian black snake, *Pseudechis porphyriacus*. Their conclusions agreed in the main with those of Mitchell, Reichert and others.



MUSCLES OF POISON APPARATUS OF RATTLESNAKE, PALATAL VIEW.

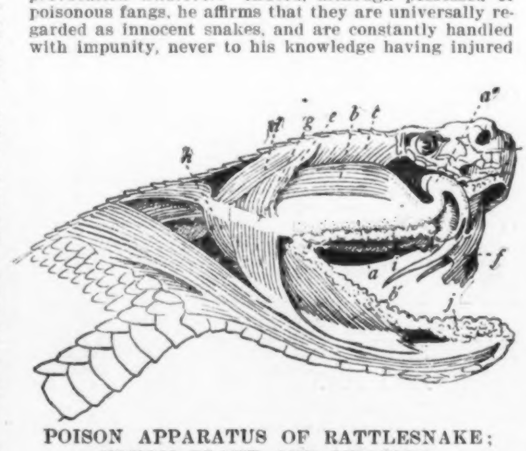
a, Spheno-pterygoid muscle; *b*, external pterygoid muscle; *c*, fascial sheath of this muscle attached to the capsule of the gland; *d*, median ridge of base of skull. After Stejneger's "Poisonous Snakes of North America."

The results of snake poisoning depend upon whether the predominating poison is elapine or viperine in its character. In the former the effect acts directly on the nervous system, while in the latter the result is principally local. Since elapine poison is always mixed more or less with viperine poison, there are also systemic effects when the poisoning is of the viperine kind, which of course is most dangerous in case of the intravenous injection.

In closing this part of the subject, it seems proper to state that the facts presented, as in the other divisions of this article, are gathered from the published writings of recognized authorities on this subject, and space of course puts a limit to the extent to which they can be discussed.

THE POISON-FANGS.

In the Coral Snakes, or Elapids, some of the species are so gentle that they use their fangs as an offensive weapon only in cases of extreme irritation. Indeed Prince Max von Wied, speaking of the Brazilian Coral Snakes (*Elaps corallinus* and *Elaps marcgravii*) states that he used to carry specimens about his person, and that they never even attempted to bite. Even the *Elaps fulvius*, or Harlequin Snake, of our country is defended by no less an authority than Prof. Holbrook, who, in his work relating to North American herpetology, states that the individuals he had seen were of a very mild character, and could not be induced to bite *under any provocation whatever*. Indeed, although possessed of poisonous fangs, he affirms that they are universally regarded as innocent snakes, and are constantly handled with impunity, never to his knowledge having injured anyone. In another place, however, Holbrook calls their fangs "instruments of destruction," and describes them as hollow and fastened, one on each side of the upper jaw, to the anterior end of the maxillary bone. In this position they may certainly become a very dangerous weapon, and Dr. Stejneger demonstrates that "the little beauty is fully capable of using it when required."



POISON APPARATUS OF RATTLESNAKE; VENOM GLAND AND MUSCLES.

Lateral view. *a*, Venom gland; *a'*, venom duct; *b*, anterior temporal muscle; *b'*, mandibular portion of same; *c*, posterior temporal muscle; *d*, digastricus muscle; *e*, posterior ligament of gland; *f*, sheath of fang; *g*, middle temporal muscle; *h*, external pterygoid muscle; *i*, maxillary salivary gland; *j*, mandibulary salivary gland. Reproduced from Stejneger's "Poisonous Snakes of North America."

With reference to the fangs of the Coral Snakes, the same authority remarks: "The *Elaps* is provided with permanently erect, perforated fangs; that is, there is found at the front end of each upper jawbone one solitary curved tooth, which has a channel running through its center and a groove on its anterior surface, and which is not followed by any other teeth on the upper jaw-bone, while the other snakes with which it can be confounded, have no such perforated fang, but, instead, a series of smaller solid teeth on the entire length of the bone in question!"

The rattlesnake has long, curved fangs in the anterior portion in the upper jaw. They are similar to those in the Elapids, but much larger, and differ from these others by being folded up toward the palate, "somewhat," as Dr. Stejneger says, "like the blades of a jack-knife when not in use." This does not mean that the fangs themselves are movable; for, on the contrary, they are solidly fixed in their sockets; but, whereas in the Elapids the maxillary bones, into which the fangs are fastened, are elongated and horizontal (just as in the harmless snakes), in the Crotalids they are extremely shortened, and higher than they are long.

In the Elapids the fangs are inserted nearly at right angles, whereas in the Crotalids, as already remarked, they more nearly represent the blades of a knife, the jawbone representing the handle, and it is the jawbone which is movable vertically, and not the fang alone. The above cut shows well the poison apparatus of the rattlesnake, as well as the venom gland and the muscles, while the next cut—a palatal view—shows more satisfactorily the muscles which elevate and depress the fangs.

"The whole poison apparatus," writes Dr. Stejneger in another place, "has very appropriately been compared to a hypodermic bulb syringe; the needle, with its obliquely cut point and slit-like outlet, representing the fangs, the bulb corresponding to the poison glands, and the muscles of the hand which presses the bulb, performing the same task as the anterior temporal muscle of the snake."

TREATMENT FOR SNAKE-BITES.

Numerous indeed are the methods of treatment which have been suggested for snake poisoning and in many cases the discoverer doubtless believed his own remedy to be the all-and-only powerful one. It must be remembered, however, that the majority of them were given to the world before analysis had shown what snake venom consisted of. They must therefore have been largely guess work. But when Bonaparte, Mitchell, Fayver, Lauder Brunton, Wall, Vincent Richards, Calmette, and others had concluded their experiments, then and only then could remedies formulated on a scientific basis be furnished.

From Dr. Mitchell we learn that by mixing any venom with a strong enough solution of potassa or soda, its power to kill is destroyed. And so also by the use of a solution of iodine, perchloride of iron, or bromohydric acid, but in lesser degree. He regards permanganate of potash, however, as the best solution, and remarks that if this agent be injected as soon as possible through a hollow needle, wherever it touches venom, it destroys it. "If at once we can cut off the circulation by a ligature," he writes, "and thus delay absorption, and then use permanganate freely, we certainly lessen the chances of death."

The first effect of the venom seems to be to lessen suddenly the pressure under which the blood is kept while in the vessels, and at that stage any alcoholic stimulant would be useful, although it can hardly be doubted that many a man has been killed by too powerful a stimulant at such a time, and Dr. Mitchell affirms that men dead drunk with whisky and then bitten, have died of the bite.

Dr. A. Calmette, of Paris, found by experiments some years ago that the hypochlorites of sodium and lime would neutralize the venom by chemical action. Chloride of gold was found to be of equal value, but ordinary chloride of lime gave perhaps the best results of all. He expressed himself as certain that, in the absence of any other treatment, this last-mentioned substance would prove an adequate remedy for rattlesnake bites, and this is probably the worst form of snake poisoning that we in North America are likely to encounter.

A discussion of the remedies for snake-bites would be incomplete without a reference to Dr. Calmette's anti-toxin treatment. In this the serum is obtained much in the same manner as the anti-diphtheritic serum, i. e., by inoculating horses with cobra poison. It can be procured from the Pasteur Institute at Lille, France, and is said to have both preventive and therapeutic effects.

Dr. Stejneger, who has made an exhaustive study of the subject, says: "In very acute cases, in which the venom has been injected directly into the circulation, no matter by what kind of a snake, the chances for recovery are very slight indeed. The only chance in such cases seems to be to stimulate the nervous centers as speedily as possible, the best-known means to this end being injection of large doses of strychnine, if necessary, intravenously, until tetanic effects are obtained and the patient roused from the coma which has probably seized him. This result obtained, other systematic or local remedies, as the case may require, can then be applied."

Dr. Stejneger is of the opinion that, as a rule, amputation or cauterization should be resorted to only in very extreme cases, where the victim is absolutely isolated and far removed from any opportunity to seek proper treatment. "After all," he adds, "the main thing really to be done is to assist Nature in her effort to get rid of the poison, by keeping the sufferer alive until by natural processes it has passed out of his system."

The extent of this article could of course be prolonged indefinitely by presenting *in extenso* the results of the numerous experiments that have been made, but space forbids, and the reader who desires to acquaint himself more fully as to remedies for snake bites can readily do so, as the literature is quite voluminous.

I can perhaps not do better in conclusion than to quote the remarks of Dr. Mitchell in reply to queries as to what he would do if he were bitten by a poisonous snake while far away from help. He says: "If the wound be at the tip of a finger, I should like to get rid of the part by some such prompt auto-surgical

* Moissan, Le Four Electrique, Paris, 1897.

† Haber, Zeitschr. für Elektrochemie, vol. 8, pp. 1, 26, 607 (1902).

‡ Leibig's Annalen, vol. 320, pp. 231-269 (1902).

§ This is the last installment of a series of articles begun in the SCIENTIFIC AMERICAN, February 14, 1903.

means as a knife or a possible hot iron affords. Failing these, or while seeking help, it is wise to quarantine the poison by two ligatures drawn tight enough to stop all circulation. The heart weakness is made worse by emotion, and at this time a man may need stimulus to enable him to walk home. As soon as possible, some one should thoroughly infiltrate the seat of the bite with permanganate or other of the agents above mentioned. By working and kneading the tissues the venom and the antidote may be made to come into contact, and the former be so far destroyed. At this time it becomes needful to relax the ligatures to escape gangrene. This relaxation of course lets some venom into the blood-round, but in a few moments it is possible again to tighten the ligatures, and again to inject the local antidote. If the dose of venom be large and the distance from help great, except the knife or cautery little is to be done that is of value. But it is well to bear in mind that in this country a bite in the extremities rarely causes death. I have known of nine dogs having been bitten by as many snakes, and of these dogs but two died. In India there would have been probably nine dead dogs."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Import of Tropical Fruit.—The greater part of central Europe gets its supplies of tropical fruit by way of Hamburg. In the south the chief competitor is Trieste, the leading market on the Mediterranean. In the west the Spanish fruit is brought to the Paris market by rail. To supply the country along the Rhine there is considerable rivalry between Hamburg on the one hand and Rotterdam, Amsterdam, and Antwerp on the other. The fruit trade with Norway, Sweden, and Denmark is shared by Hamburg with the English dealers, but the German city controls the Russian markets by way of the Baltic. Altogether, Hamburg imported during 1901 about 47,000 tons of oranges and 10,000 tons of lemons, not to mention other kinds of fruit. During the same period only 879 tons of oranges and 120 tons of lemons were landed at Bremen.

As Bremen can offer the same advantages for handling the fruit business as Hamburg can, a movement was set on foot here about a year ago with a view of making an effort to get a large share of this trade. The Bremen senate made an appropriation for the purpose of constructing a storage house in the free port, which is provided with excellent heating and ventilating apparatus. In addition, the senate abolished the usual official fee on all auctions of fruit, and materially reduced the water-way or river tax on all vessels engaged in this traffic.

The fruits imported are mainly oranges, lemons, apples, grapes, bananas, and pineapples; vegetables, such as potatoes, onions, and tomatoes, are also brought in. The imports come from Sicily and Spain, with which countries Bremen has excellent and regular steamer connections.

The first shipments of southern fruits began to arrive last November, and many tons have been imported during the last months. They are sold at auction, and thus far the sales have been very successful, all the fruit having been rapidly disposed of at satisfactory prices. The fruit packer in Italy and Spain buys oranges while the crop is still on the trees, has them picked, sorted in the storehouses according to size and quality, packed, and consigned to a broker in some fruit market. Upon arrival at their destination, the goods are taken to the storage house, where the consignee divides the entire shipment into lots of 20 and 30 cases, one of which is opened for inspection and sampling. As soon as convenient, the fruit is sold at auction to the highest bidder and the proceeds are credited to the shipper, after deducting expenses for freight and selling. In most cases the buyers are permitted to leave the lots purchased in storage for a limited time, free of charge, in order to resell or repack for further transportation.

Though this promising fruit market is not so readily accessible to fruit growers on the western continent as it is to their competitors in Europe, American dealers would do well to carefully examine the new arrangements at Bremen and the opportunities they offer. About 4,000 barrels of American apples were sold at the four auctions recently held here, which, of course, is but a small beginning. However, I see no reason why, in the course of time, American fruit of all kinds should not be unloaded at this new storage house at Bremen and disposed of at profitable prices. The Germans are not great fruit eaters, when compared with other nations. While in England the annual consumption of southern fruit amounts to 15 pounds per head, it averages not quite 3 pounds per head in Germany; but this simply shows that there is great room for improvement, and it is not unreasonable to hope for a steady increase of the demand for fruit in this market.—Henry W. Diederich, Consul at Bremen.

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